The AMSAT Journal

Volume 16 No. 6
November/December 1993

Editor: John Hansen, WAØPTV
Editorial Staff: Ron Long, W8GUS
Walter Daniel, KE3HP, Buzz Gorsky, WH6I

CONTENTS

DOVE Awakens! 1

Apogee View: 3
By Bill Tynan, W3XO

Study of RadioSport Satellite Doppler Shift Anomalies ...6
By J. Branegan, GM4IHJ

The 1993 AMSAT Space Symposium 12
By John Hansen, WAØPTV

The October AMSAT Board of Directors Meeting 16
By Bill Hook, W3QBC

Heard on the Downlink ...24
By John Hansen, WAØPTV

Development of a Portable Mode S Groundstation 25
By Ed Krome, KA9LNV

Satellite Orbital Elements 28
By Ray Hoad, WA5QGD

S-Band 16t Helix Update ..29
By James Miller, G3RUH

AMSAT-OSCAR-13 Eclipses 30
By Graham Ratcliff, VK5AGR

DOVE Awakens!

DOVE (Digital Orbital Voice Encoder), which had been relatively dormant for many months, has been awakened. It is now actively sending telemetry and short text messages on 145.825 Mhz. The signals are strong and can generally be received with a handheld radio.

Many individuals have devoted an enormous amount of time and energy over the last couple of years to the DOVE recovery effort. Early work was undertaken by Bob McGwier, N4HY and Harold Price, NK6K. Most recently, these efforts have been organized by Jim White, WDØE and have included substantial contributions from Bob Diersing, N5HAD and Bill McCaa, KØRZ. Thanks to their hard work, it is now possible to load software on 2 meters in half duplex mode. Previously it had been necessary to communicate with DOVE by transmiting packets on 2 meters and listend for the "ack" packets by ear on a high performance S band receiving system. This often involved relaying the S band signal by a long-distance telephone link... a particularly cumbersome procedure.

DOVE telemetry can be successfully copied on a garden variety 1200 baud packet system with a 2 meter FM receiver. Thus, it is well within the capabilities of most AMSAT members. Most outdoor antennas work satisfactorily, but horizontal polarization generally works betterthan vertical. A directional antenna is not necessary. When receiving on a handheld radio, best results can be obtained by holding the antenna parallel to the ground. The telemetry can be automatically displayed as engineering data using programs such as TLMDC II (available from AMSAT -- $20 for members). You can obtain a DOVE QSL card by sending a reception report to py2bjo@amsat.org on Internet or to Junior DeCastro, PY2BJO, 119 Macaubal, Sao Palo, Brazil 01254.

DOVE is not yet speaking, but if all goes well, the next step will be to load a housekeeping task module that includes the same voice test code that has been previously used.

It now appears to be only a matter of time until DOVE becomes fully operational on 2 meters, transmitting messages of peace and greeting to the world's children as originally envisioned by its "father", Junior DeCastro, PY2BJO. WDØE described the potential of DOVE at the 1993 AMSAT-NA Space Symposium. Details on obtaining the proceedings are contained elsewhere in this issue.

AMSAT-NA
850 Sligo Avenue
Silver Spring, MD 20910

Second Class
POSTAGE PAID
at Silver Spring, MD
and at additional
mailing offices

26557 WB9SGP 1994.04
STEPHEN BELTER
510 ROSE ST.
WEST LAFAYETTE IN 47906

Satellite Tracking

with your PC and the Kansas City Tracker & Tuner

The **Kansas City Tracker** is a hardware and software package that connects between your rotor controller and an IBM XT, AT, or clone. It controls your antenna array, letting your PC track any satellite or orbital body. The **Kansas City Tracker** hardware consists of a half-size interface card that plugs into your PC. It can be connected directly to Kenpro 5400A/5600A or Yaesu G5400B/G5600B rotor controllers. It can be connected to other rotor assemblies using our Rotor Interface Option.

The **Kansas City Tuner** Option provides automatic doppler-shift compensation for digital satellite work. The **Tuner** is compatible with most rigs including Yaesu, Kenwood, and ICOM. It controls your radio thru the radio's serial computer port (if present) or through the radio's up/down mic-click interface. The **Kansas City Tuner** Option is perfect for low-orbit digital satellites like the NOAA and Microsat satellites.

The **Kansas City Tracker** and **Tuner** include custom serial interfaces and do not use your computer's valuable COMM ports. The software runs in your PC's "spare time," letting you run other programs at the same time.

The **Kansas City Tracker** and **Tuner** programs are "Terminate-and-Stay-Resident" programs that attach themselves to DOS and disappear. You can run other DOS programs while your antenna tracks its target and your radios are tuned under computer control. This unique feature is especially useful for digital satellite work; a communications program like PROCOMM can be run while the PC aims your antennas and tunes your radios in its spare time. Status pop-up windows allow the user to review and change current and upcoming radio and antenna parameters. The KC Tracker is compatible with DOS 2.00 or higher.

Satellite and EME Work

The **Kansas City Tracker** and **Kansas City Tuner** are fully compatible with N4HY's QUIKTRAK and with Silicon Solution's GRAFTRAK. These programs can be used to load the **Kansas City Tracker's** tables with more than 50 satellite passes.

DX, Contests, and Nets

Working DX or contests and need three hands? Use the **Kansas City Tracker** pop-up to work your antenna rotor for you. The **Kansas City Tracker** is compatible with all DX logging programs. A special callsign aiming program is included for working nets.

Packet BBS

The **Kansas City Tracker** comes complete with special control programs that allow the packet BBS user or control-op to perform automated antenna aiming over an hour, a day, or a week. Your BBS or packet station can be programmed to automatically solicit mail from remote packet sites.

Vision-Impaired Hams

The **Kansas City Tracker** has a special morse-code sender section that will announce the rotor position and status automatically or on request. The speed and spacing of the code are adjustable.

The **Kansas City Tracker** and **Tuner** packages include the PC interface card, interface connector, software diskette, and instructions. Each Kansas City unit carries a one year warranty. The KC Tuner is not available as an after market upgrade.

- KC Tracker package includes cable for Yaesu/Kenpro 5400/5600 and rotor interface option (to connect to any rotors) $229
- KC Tracker package plus KC Tuner $319
- N4HY QuikTrak software ..... $ 80

Visa and MasterCard accepted.
Shipping and handling: $5, ($20 for international shipments).
Prices subject to change without notice.

NEW ADDRESS!

L. L. Grace
Communications Products
P.O. Box 1345 • Voorhees, NJ 08043 • U.S.A.

For more info: Telephone 609-751-1018
FAX 609-751-9705
CompuServe 72677,1107

10/92

L. L. Grace also manufactures the DSP-12 Multi-Mode Communications Controller. Call or write for more information.

The AMSAT Journal Staff

Editor in Chief: John A. Hansen, WAØPTV
Circulation: Martha Saragovitz

AMSAT-NA Board of Directors:

Tom Clark W3IWI, Dick Daniels W4PUJ
Junior deCastro PY2BJO, Bill Tynan W3XO
Bob Diersing N5AHD, Joe Kasser W3/G3ZCZ
Andy MacAllister WA5ZIB

AMSAT-NA Officers

President:
Bill Tynan W3XO
Executive Vice President:
Ray Soifer W2RS
Vice President, Engineering:
Dick Jansson WD4FAB
Vice President, Operations:
Keith Pugh W5IU
Vice President, Manned Space Programs:
Frank Bauer KA3HDP
Vice President, Field Operations:
Mike Crisler N4IFD
Vice President, Publications:
Drew Deskur KA1M
Vice President, User Services:
Andy MacAllister WA5ZIB
Vice President, Strategic Planning:
Keith Baker KB1SF
Vice President, Development:
Bruce Croskey WHØI
Treasurer:
Art Feller KB4ZJ
Corporate Secretary:
Martha Saragovitz
President Emeritus:
Tom Clark W3IWI

Editorial Office: **John A. Hansen, WAØPTV, 49 Maple Avenue, Fredonia, NY 14063. Internet: wa0ptv@amsat.org, Compuserve: 70353,460.**

Production Office: Executive Printing Services, Inc. 6640 Ammendale Road, Beltsville, MD 20705.

Advertising Office: AMSAT Headquarters, 850 Sligo Avenue, Silver Spring, MD 20910-4703.

The AMSAT Journal (ISSN:1047-3076) is published bimonthly (Jan, Mar, May, July, Sept, Nov) by AMSAT-NA, 850 Sligo Avenue, Silver Spring, MD 20910-4703. Telephone: 301-589-6062. Second Class postage paid at Silver Spring, MD and additional mailing offices. Postmaster: send address changes to *The AMSAT Journal*, 850 Sligo Avenue, Silver Spring, MD 20910-4703.

Opinions expressed in *The AMSAT Journal* are those of the article author and not necessarily those of AMSAT-NA. Copyright (c) 1992 by AMSAT-NA, The Radio Amateur Satellite Corporation. AMSAT is a registered trademark. Reproduction of material from *The AMSAT Journal*, mechanical, electronic, or photocopy, is prohibited unless written permission is obtained from the author.

The AMSAT Journal staff is always interested in article submissions. Whenever possible, text should be on IBM or MacIntosh compatible diskette (3 1/2 inch preferable) with hard copy. AMSAT-NA reserves the right to select material for *The AMSAT Journal* based on suitability of content and space considerations. The editors of this publication are volunteers giving freely of their talents, time, and efforts to produce *The AMSAT Journal.*

Observations on the 1993 Space Symposium

by Bill Tynan W3XO
President, AMSAT-NA

Another Annual Meeting and Space Symposium has come and gone. And, I must say that this was one of the best to date. Attendance was over 170 - not a record, but a good turn-out. It was particularly gratifying to see so many people from countries beyond our borders.

A large measure of the reason for the success of this year's affair is due to the work of Keith Pugh and his able group of workers. Believe me, "workers" is the right word to describe their function. Anyone who has put on a meeting such as this can attest to how much work is involved.

Two of the unusual features at this year's gathering were both due to the efforts of one man. One was the popular escorted tour of Dallas/Fort Worth area electronic emporiums and surplus outlets. The other was an antenna range for checking the performance of some of our favorite satellite arrays. A few surprises were in store for many of us, especially with regard to the circularity of some of our "circularly" polarized antennas. The individual who organized both of these events was Kent Britain WA5VJB. Our thanks to him for adding something a little extra this year. Of course many people helped in putting on the meeting, some of whom received recognition in the form of a plaque. But, there are always a few who are missed. My apologies, and thanks, to them.

At each Annual Meeting, we try to especially honor those AMSAT members who have made special contributions during the past year, and often in many years previous to that. Some are those who labored to put the meeting together. Others are those who have made contributions in a variety of endeavors. One of the dangers of presenting such honors is that, invariably, someone who is most deserving is omitted. However, I don't believe that the fact that this is bound to happen is sufficient reason for abandoning the practice.

With that in mind, the following list of plaques awarded this year, along with their accompanying citations, is presented so that those who could not attend the Annual Meeting can appreciate the diversity and dedication of those who toil in support of the amateur space program.

Plaques Presented at the 1993 AMSAT Annual Meeting and Space Symposium Arlington, Texas October 8 through 10

Haruo Yoneda JA1ANG

For many years of contribution to the Amateur Space Program including serving as a member of the AMSAT Board and providing valuable liaison with JAMSAT and JARL.

Ron Broadbent G3AAJ

For significant contributions to the amateur space community through tireless work as Secretary of AMSAT-UK.

Barry Goldwater K7UGA

For significant help to the amateur space program by aiding in the production of a Phase 3D video tape.

The American Radio Relay League

For significant help to the amateur space program by mounting a successful Phase 3D fund-raising campaign.

Mark Kanawati N4TPY

For outstanding contributions to EYE-SAT amateur package.

AMRAD

For significant contributions to the EYE-SAT amateur package.

IT-AMSAT

For outstanding effort constructing the Italian Microsat.

David Liberman XE1TU & the UNAMSAT Team

For an outstanding job of building the UNAMSAT spacecraft.

Brooks Van Pelt KB2CST

For many years of support through contributions from sales of Kansas City Tracker and DSP-12.

John Hansen WAØPTV

For many contributions to the AMSAT Journal.

Paul Urie N7QOC

For an excellent job as Editor of the AMSAT Journal.

Bob Carpenter W3OTC

For outstanding work on the membership data base.

Dieter Schliemann KX4Y

For outstanding work on the membership data base.

Keith Baker KB1SF

For donation of his excellent book "How to use the Amateur Radio Satellites".

Roy Welch WØSL

For donation of his excellent ORBITS tracking program.

Perry Klein W3PK

For representing AMSAT to various Government agencies and frequency allocations bodies

Martha Saragovitz

For many years of devoted service.

Keith Pugh W5IU

For superb job of coordinating this year's meeting & symposium.

Ray Hoad WA5QGD

For willingly undertaking the chairmanship of the Space Symposium Committee and other dedicated support throughout the years.

Harold Bulmahn W5DSG

For invaluable help organizing this year's meeting & symposium.

Doug Howard KG5OA

For organizing the papers for this year's Space Symposium and devoted service as assistant editor of the AMSAT Journal.

Frank H. Perkins Jr. WB5IPM

For a fine job as moderator for this year's symposium.

Dick Campbell N3FKD

For a superb job as master of ceremonies for the 1993 banquet.

Kent Britain WA5VJB

For setting up and running the antenna range and conducting the surplus tour for the 1993 Annual Meeting & Space Symposium.

James Miller G3RUH

For encouragement of Mode S operation through example, and various excellent articles.

Harold Price NK6K

For continuing dedicated effort to activate DOVE.

Jim White WDØE

For continuing dedicated effort to activate DOVE.

Bob Diersing N5AHD

For continuing dedicated effort to activate DOVE.

Paul Williamson KB5MU

For continuing support in the maintenance of the health and utility of AO-16.

Wray Dudley W8GQW

For many years of keeping the Sunday afternoon nets operating.

Mel Roman KA2UPD

For establishing and operating the AMSAT dial-up bulletin board.

Ralph Butler

For outstanding & dedicated leadership of the WSU work on the Phase 3D structure.

Jaim Parsons

For excellent skilled work on the Phase 3D structure.

Darrel Emerson AA7FV

For extensive computer processing of AMSAT-OSCAR-13 ZRO Test signals sent at a record low level of "A".

The Northern Chautauqua Amateur Radio Club

For First Place finish in the 1993 AMSAT Field Day Competition.

Larry Brown NW7N

For valuable assistance in the Field Ops Department and personally representing AMSAT at many hamfests.

Roger Ley WA9PZL

For valuable and untiring support of AMSAT as Area Coordinator for Louisiana.

Dave Reeves KF6PJ & Physics Students of Chaminade College Preparatory

For a fine job of producing the AMSAT Educational Newsletter.

Rosalie White WA1STO

For outstanding contributions directing SAREX educational activities.

John G. Nickel WD5EEV

For outstanding contributions and personal dedication to the SAREX program and Working Group.

Karen L. Nickel WD5EEU

For outstanding contributions to SAREX.

Graham Ratcliff VK5AGR

For outstanding contributions as the Australian school group coordinator and prime SAREX telebridge station.

Gordon VK6IU and Jean Williams

For outstanding contributions to SAREX and the Shuttle astronauts as the personal contact bridge with their families.

Steve Teegarden WH6IC

For outstanding contributions and tireless efforts as a SAREX telebridge station.

Stan Wood WA4NFY

For outstanding contributions and tireless efforts as a SAREX telebridge station.

Ralph Warner N6MNN

For outstanding contributions and tireless efforts as a SAREX telebridge station.

Sterling Park Amateur Radio Club

For outstanding efforts managing STS-45 SAREX QSLs.

Dayton Amateur Radio Association

For outstanding efforts managing STS-50 SAREX QSLs.

Terry Jones NZ8C

For outstanding contributions as a SAREX school group technical coordinator.

Don Hedinger, N4MSN

For outstanding contributions as a SAREX school group technical coordinator.

Pat Kilroy WD8LAQ

For conducting the DC Area AMSAT Net, writing AutoCall Column, serving as AMSAT's FAR representative and outstanding contributions as SAREX school group technical coordinator.

Howard Ziserman WA3GOV

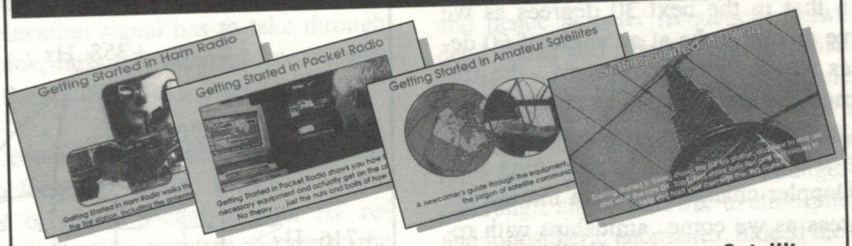
For continuing a fine job representing AMSAT at hamfests & conventions and outstanding contributions as a SAREX school group technical coordinator..

In addition, a special letter of commendation was sent to Bill Hook W3QBC for his tireless work assisting Martha in the office and serving as Assistant Treasurer, thus relieving Art Feller of some of the drudgery that job entails. Incidentally, it was Bill who transcribed the minutes of the May Board of Director's meeting as is doing the same for the one held following this year's Annual Meeting. Many have commented that the May minutes were the most complete we have ever produced.

I was very surprised and gratified by the award presented to me. My thanks to all involved in producing it.

The Authority on Amateur Radio CQ

CQ's new videos bring the exciting world of amateur radio into your living room!



Getting Started in Ham Radio.
CQ's experts show how to select equipment and antennas. Which bands to use. How to use repeater stations for improved VHF coverage. How to get the most out of your station.

Getting Started in Packet Radio.
Shows how to get started in using your computer on the radio. Includes step-by-step instructions on making packet contacts and using packet bulletin boards, networks and satellites.

Getting Started in Amateur Satellites.
Shows you how to set up your satellite station and how to find and track ham satellites. How to access current satellites and contact far ranging countries around the world.

Getting Started in DXing.
Top DXers share their experience on equipment, antennas, operating skills and QSL-ing. See hams work rare DX around the world. If you're new to DXing this video is for you.

The New CQ Video Library!

Only $19.95 each!

Now, for the first time, CQ brings you all our experience on video tape. These videos will help you get started and improve your existing skills in amateur radio.

Whether you're a new ham or just getting started in Packet, Satellite or DXing we've got your video. Each tape gives you first-hand tips from hams who are on the air. They take you under their wing and show you just what it takes to get the most out of our hobby!

They're only $19.95 each (plus shipping and handling).

Available at your local dealer or order from CQ directly (516) 681-2922

CQ Communications, Inc. 76 North Broadway, Hicksville, NY 11801
Fax (516) 681-2926

Study of RadioSport Satellite Doppler Shift Anomalies

by J. Branegan, GM4IHJ CEng MIEE

One way to visualise the pattern of Doppler frequency shift around an orbiting satellite is to see it as an infinite series of cones spreading out from the satellite in all directions. Figure 1 shows a small set of these frequency cones. The highest frequency is directed straight ahead, whilst the lowest frequency is directed straight astern. Coming away from the bow or stern, frequency changes slowly such that even after shifting out to an angle of 30 degrees with respect to bow or stern the frequency only changes about 13% . But as we get further round from bow or stern the frequency change begins to increase such that in the next 30 degrees as we move around to be at an angle of 60 degrees relative to bow or stern, the frequency change increases by another 37%, i.e., a total shift from bow or stern to a 60 degree angle of 50%. The remaining 50% of Doppler change occurs in the last 30 degrees as we come amidships with respect to the satellite, i.e., a still greater rate of change than in the previous 30 degree segment.

This Doppler pattern is 3 dimensional. It extends all the way around the satellite. Whether you view from 30 degrees astern and above the satellite, or 30 degrees to the side or, 30 degrees below the satellite the doppler is the same. But change your "angle on the bow" even slightly, and you change Doppler. Moving towards the bow or stern at any aspect changes Doppler increasingly slowly. Moving towards a midships view point produces an increasingly larger rate of change of Doppler frequency. So using these rough rules of how the Doppler pattern affects what frequency you hear, and how this frequency changes with time, should tell you how your angle with respect to the satellites bow is changing.

Using a frequency plot you can work out what frequencies to expect at any part of a satellite pass whether close to or far away from your station.

Orientation of a Satellite On Your Station Horizon.

The Doppler pattern shown in Figure 1 suggests that you can hear -716 Hz of Doppler shift when directly astern of the satellite, and +716 HZ of shift when directly ahead of the satellite. But these viewing positions are only possible if you are yourself up in space.

As Figure 2 shows, when you are on the ground and the satellite is on your horizon, your angle of view is the same as the radius angle of the satellite footprint. For example, with the RS satellites orbiting at 1000 kms altitude their footprint radius on the earth is approximately 30 degrees. So you see the satellite from a viewpoint 30 degrees beneath its bow or stern depending on whether it is approaching or receding from you. Equally important, this is the smallest "angle on the bow" any ground station can achieve. So you never actually hear the full + or - 716 Hz of Doppler shift.

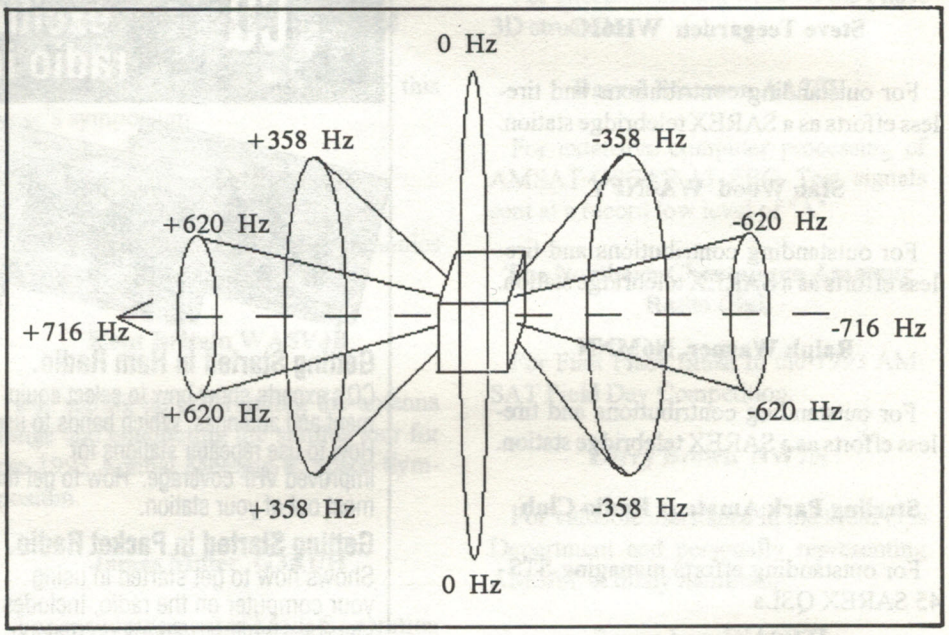


Figure 1

The Doppler Pattern Around a 29 Mhz Satellite Beacon

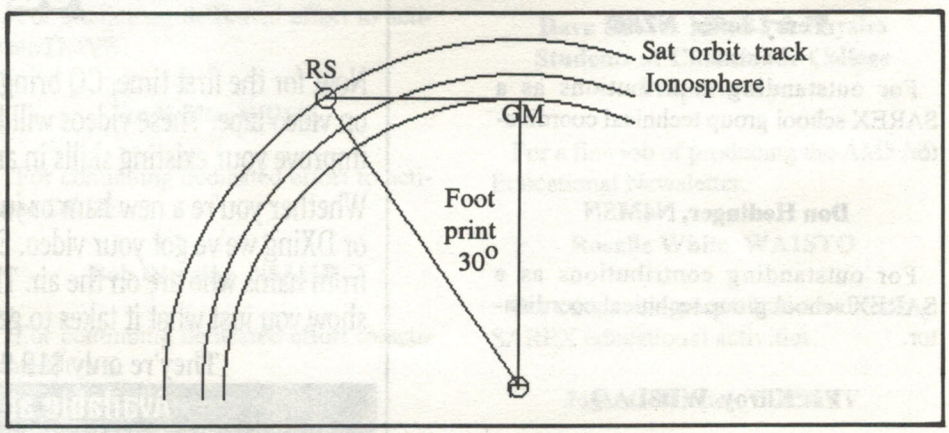


Figure 2

Satellite Angle of Sight at Horizon

You never get more than + or - 620 Hz, and you get that, only on orbits coming directly towards or away from you. On more distant passes you get far less than + or - 620 Hz of Doppler. But whatever range of doppler you get it is always balanced about 0 Hz, the Doppler you get when the satellite is at its closest point of approach to your station, and "angle on the bow" is 90 degrees.

All Known Signal Path Modifiers Lie Below the Satellite

Any signal coming to your station from the satellite must descend through both the ionosphere and the atmosphere. In practice the ionosphere bends the signal path most when the satellite is near your station horizon, and adding to this the atmosphere is capable of major redirection of the signal at angles of sight passing near the horizon. So we can expect maximum deviation from a straight line of sight when the satellite is on the station horizon. Actual conditions will vary greatly with time of day and weather conditions, particularly atmospheric pressure, which can be highly variable.

When considering ionospheric effects it is necessary to bear in mind that the relevant portion of the ionosphere is the part that is between you and the satellite. The ionosphere above your station is only relevant if the satellite makes an overhead pass. At other times the ionosphere your signal descends through is roughly halfway back to the satellite, which in the case of a satellite on the horizon can be the ionosphere over a thousand kms from our station; a location where solar illumination can be very different from that which is directly overhead. As a result, Doppler effects on an RS satellite to the west can be very different from those when the bird is to the east (under a different Sun angle). Worse still this effect can cause serious changes on north/south passes at high latitude stations near auroral zones.

Also important and sometimes over looked is the nature of the station horizon. At GM4IHJ the horizon to the north is clear down to 1 degree , to the northeast down to 3 degrees, to the east, 6 degrees, to the south, 4 degrees, to the southwest 2 degrees, and from west southwest to north, it is clear down to 1 degree. So on orbits between north, through east and south to south west, GM4IHJ simply cannot view the satellite through the lower atmosphere because his line of sight is obscured. This sort of local complication must be considered before an individual station operator can get even a half clear picture of what sort of signal path perturbation he can expect on any particular azimuth bearing.

Practical Oservation of Doppler Irregularities

The Doppler frequency shift we hear from an RS satellite is not an exact representation of the changing line of sight angle to the satellite. Signals that start out towards us from the satellite never get to us. The 3 layers of the ionosphere (D, E and F) bend the signal path in an irreglar manner and at low angles of elevation as we acquire or lose the satellite the path the low elevation signal has to take through the thick, turbulent atmosphere can also twist the signal about a great deal.

All you need to see this happening is an audio freqency meter. Match it to the phone or record socket of your HF receiver, transmit a constant marker to the satellite and tune the satellite audio to show about 1200 Hz on the meter. Set the meter to report frequency ever 20 seconds or so, and write down the signal frequency you read. Do not tune the receiver, just record the descending frequency. Table 1 shows a typical run on RS12 starting at AOS.

Note that the frequencies given in the above experiment relate to an arbitrarily chosen audible note at the station receiver. Overall Doppler shift (uplink+downlink), was 1200 - 840 Hz = 360 Hz on a signal tracked over roughly half of a middle distance pass. The Doppler shift is two way because the experimenter transmitted the uninterrupted carrier signal to the satellite so it acquired both up and down Doppler before it got back to the station receiver. This experiment cannot be performed on the satellite beacon since it is an interupted carrier and hence not suitable for audio frequency measurement.

Taking a reading every 20 seconds, it is clear that the first 14 readings show a very turbulent picture consistent with the signal coming through a thick low elevation path in the atmosphere. We expect in theory that the signal will drop very slowly, but clearly it does not. Then in the last 13 readings the pattern of decreasing Doppler we have been expecting all along begins to assert itself but even here it is not a smooth descent. The rate of change in these right hand columns is of the correct order overall, but it is far from smooth.

The observed frequency change in these random jumps is not Doppler. What is happening is that the bent path we hear it on, at the start is bent away from us and quickly lost and we hear it via another path which originally was not headed in our direction but has been bent towards us. Each different path left the satellite at a different angle to its course through the heavens . So actual Doppler on a path = max Doppler x cosine of the angle this particular track had with respect to the satellites bow, on leaving the satellite. As we change path , we change angle on bow and hence Doppler frequency. Between dead ahead and sideways on the change can be as much as 1 kHz (2way Doppler). As the results in the above table show we are not getting this change every 20 seconds, but we are getting slight changes of path/angle all the time due to atmospheric and ionospheric anomalies. Indeed the table above shows that this pass encountered a very disturbed atmosphere during first 4 minutes and a slightly disturbed ionosphere during the second 4 minutes.

Large Doppler Anomalies

When the HF signal from a RadioSport satellite is heard at your station, it is normally (98% of the time), somewhere near the theoretical Doppler frequency expected for that angle on the satellites bow, subject to small short duration anomalies of 30 or 40 Hz on say 600 Hz, due to the ionospheric and atmospheric effects described above. But at other much rarer times the signal can be subject to grossly abnormal Doppler anomalies (300 or 400 Hz). These much bigger deviations from the anticipated doppler have at least 3 distinct types :

a. Long duration events lasting for 10 minutes or so of the satellite pass,

b. Short duration events where the doppler is far from normal, and

c. Long duration events were perhaps both a normal Doppler signal and an abnormal wide band fluttering signal is also present for several minutes.

Table 1

Doppler Shift on a Typical RS 12 Pass

Obs#	Freq(Hz)	Δ	Obs#	Freq(Hz)	Δ	Obs#	Freq(Hz)	Δ	Obs#	Freq(Hz)	Δ
1	1200	na	8	1230	- 50	15	1200	- 10	22	1080	- 20
2	1150	- 50	9	1250	+ 20	16	1190	- 10	23	1050	- 30
3	1200	+ 50	10	1250	0	17	1170	- 20	24	1000	- 50
4	1240	+ 40	11	1220	- 30	18	1160	- 10	25	960	- 40
5	1240	0	12	1210	- 10	19	1150	- 10	26	910	- 50
6	1220	- 20	13	1220	+ 10	20	1140	- 10	27	840	- 70
7	1280	+ 60	14	1210	- 10	21	1100	- 40			

The causes of these anomalies are only gradually becoming clear, as more observers carry out satellite Doppler studies.

Large, Long Duration Doppler Anomalies

This type of anomaly features a Doppler shift which when first noticed is either a little too high on a satellite coming down from high latitude, or far too low on a satellite coming up from low latitudes. At these times with the satellite coming towards the station a Doppler high of say 500 Hz is expected, but the satellite coming from high latitude has a Doppler of say 600 Hz, and even more interesting as the satellite tracks down to pass to one side of your station the Doppler remains the same (very high) although it should be dropping in frequency quite rapidly. If you continue tracking as the satellite goes past and away from you towards lower latitude the signal heard remains high even when the satellite is showing its stern to your station. Indeed Doppler high in these cases can be observed for perhaps as much as 10 or 15 minutes, with the frequency heard remaining constant throughout until the satellite is well down into tropical latitudes. Figure 3 shows two views of this type of anomaly.

The satellite tracks from Quebec, Canada to West Africa just outside the UK horizon. It is heard at 2056 UTC whilst over Canada with a slightly higher than usual Doppler shift. As the satellite swings down to the west of UK it is anticipated that its Doppler will fall as shown by the small circles curve on Figure 3b. However, this does not happen. The received signal holds its high Doppler consistently for 8 minutes until the satellite is far to the southeast of UK. Then after a few seconds of disturbed signal, the signal is lost. The dashed line in Figure 3a suggests that the signal has been coming off the bow of the satellite via a refractor/scatterer south east of UK, not by a great circle.

Figures 4a and 4b show a variation of the long unchanging signal coming via a low latitude reflector/scatterer. In this case the satellite is coming north passing outside the UK horizon as it travel from southern Libya, over the eastern Mediterranean, the eastern edge of the Black Sea and north of the Caspian Sea. At no time is the signal into Scotland coming via a normal great circle track, until perhaps at the very end as the satellite signal is lost over central Asia. Throughout this pass the Doppler is low (coming off the stern of the satellite). The only way a signal from the stern of the satellite can get to Scotland is via a reflector or scatterer behind and lower in latitude in respect to the point where the satellite was first heard. This path via the stern of the satellite south to the reflector then north to UK is one possible explanation of what is happening. This then, is a mirror image version of the Doppler event shown in Figure 3.

This type of long duration Doppler anomaly is more often encountered on the lower frequency satellite beacons around 20 MHz. It does occur on the 29 MHz

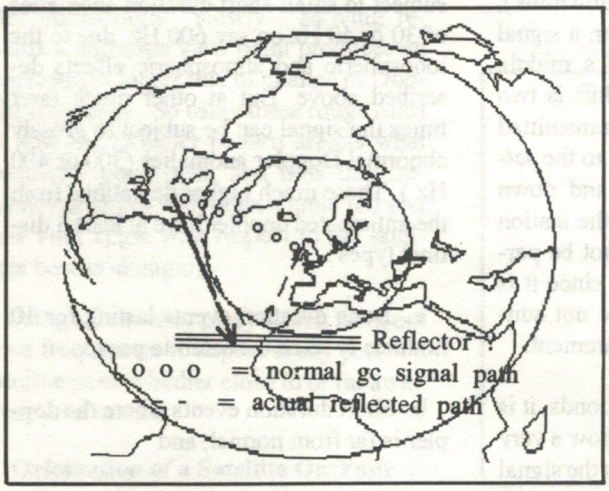


Figure 3a

SatTrack, Great Circle v Reflected Path

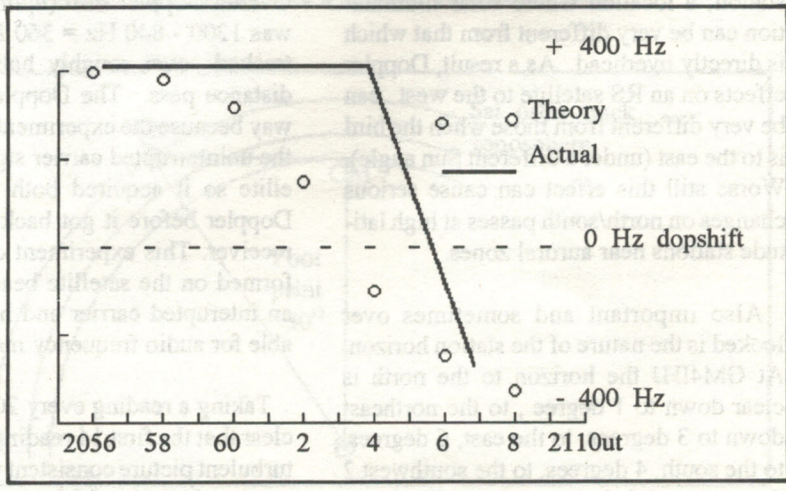


Figure 3b

Expected v Actual Doppler Curve

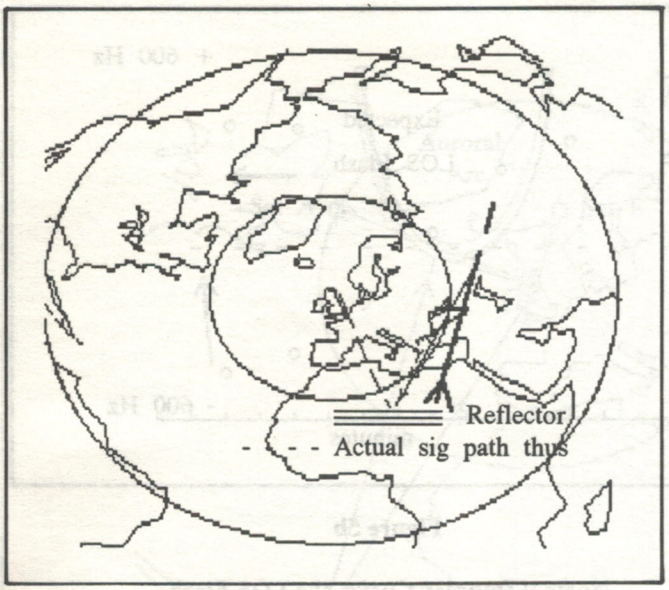


Figure 4a

SatTrack, Great Circle v Reflected Path

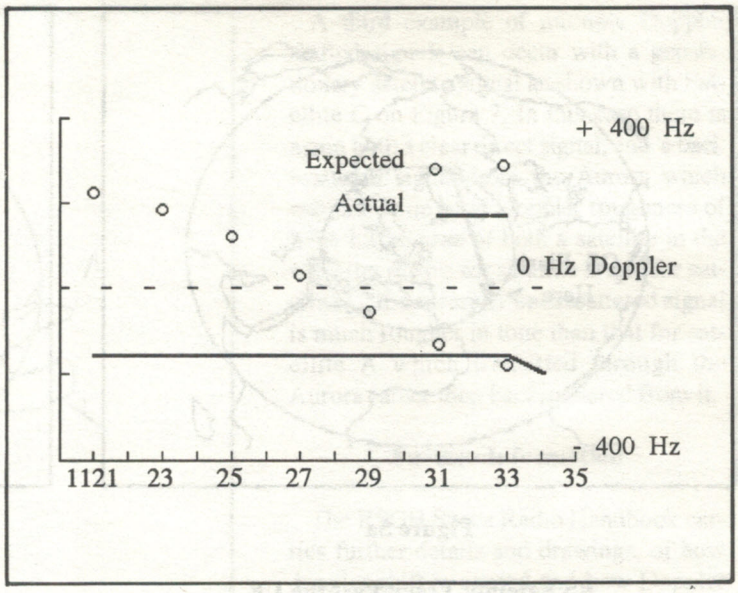


Figure 4b

Expected v Actual Doppler Curve

satellite beacons but is much less frequent because the direct great circle signal on 29 Mhz beacons is seldom blocked by the ionosphere, whereas this is a regular feature on 20 MHz.

When this type of sub-horizon Doppler anomaly is present, it is regularly accompanied by non-great circle propagation of terrestrial DX signals, such as UK to Eastern USA via the West Indies or West Africa, when there is no direct great circle propagation UK to USA. Indeed this kind of non great circle propagation of terrestrial signals is often encountered between the USA and the UK, the UK and Japan, and the USA and Japan, when the ordinary high latitude great circle path is blocked by poor propagation/low solar flux. At these times it is often possible to get DX communication by pointing ones antennas further south than the great circle path (in the northern hemisphere), provided both stations point their antennas at the reflector zone. If one station reverts to great circle azimuth pointing, the non great circle anomaly path will be lost, and communication ceases.

Short Duration, Large Anomalous Doppler

In a typical incident an HF satellite has passed in range of UK on a daylight pass and is heading away to the south or the southwest horizon (see Figure 5a). As expected the doppler shift is 300 to 500 Hz low and dropping only very slowly, in the regular pattern encountered near loss of signal at the station horizon. Suddenly in the last 5 to 10 seconds before horizon fade, the Doppler shift stops decreasing in frequency and very quickly rises higher in received frequency by 200 or 250 Hz, reaching its highest frequency as the signal finally fades at a frequency with a small Doppler low, i.e., just less than that actually transmitted by the satellite beacon. (see Figure 5b)

This sudden rise lasts only 5 or 10 seconds before the signal fades completely. It is not a step jump in frequency. Tapes of actual incidents show that it is a gradual rise albeit a very speedy one lasting just a few seconds.

The important condition at horizon loss of satellite signal, is the satellite aspect as seen from the ground station. As Figure 6 (not to scale) shows, the minimum aspect is 30 degrees with respect to the stern of the satellite, reflecting a negative Doppler shift of between 500 and 600 Hz on a 29 MHz satellite beacon, after a pass which has come near to the ground station.

If we have a Doppler shift upwards of 200 Hz or so, it must mean that we are getting the beacon signal leaving the satellite at a greater angle to the satellite's stern than the normal LOS path. To get 200 Hz shift we need to change from roughly the 30 degree path from the stern to the 60 degree path from the stern. The important consideration here is the atmosphere and there is a close analogy of this Doppler flash with a phenomena often seen at sunset. Only the atmosphere can produce a sudden path change of this magnitude when the satellite is on the station horizon. What is begin observed here, in fact, is something akin to a visual mirage.

Whilst mirages - ships in the air, water in the desert, or mountains seen on the horizon although they are 300 kms or even 1000 kms away - are rarely reported in the UK, they are not uncommon over the North Sea, out of sight of those of us ashore. Indeed they do bring VHF ducts which guide DL and PA signals across the sea into the UK east coast. Away from the UK, both north in the Arctic and south over the temperate zone Atlantic, visual mirages and HF and VHF signal ducting are common over calm seas, deserts, ice fields and pack ice.

Where you get visual mirages you get anomalous radio propagation so long as the half wavelength of the signal does not exceed the height of the duct. This in practice limits us to 10m wavelength and smaller. Most ducts are only a few meters high, much more rarely they can achieve 30 meters or more in height. They are most often present over water or ice in still, low wind velocity, conditions - conditions usually encountered under an atmospheric high pressure region.

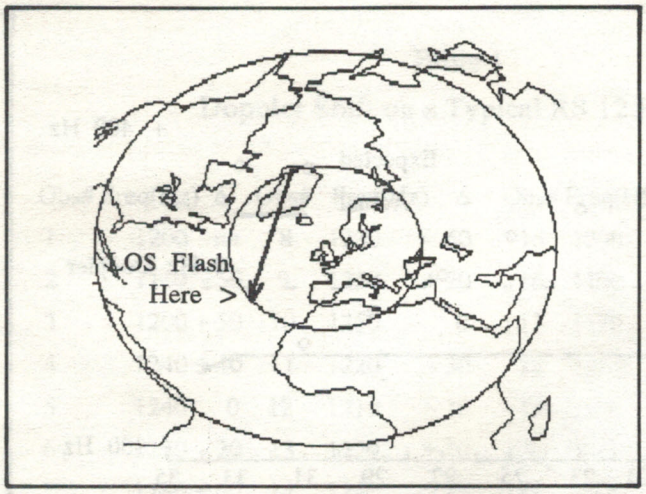


Figure 5a

RS Satellite Track Past the UK

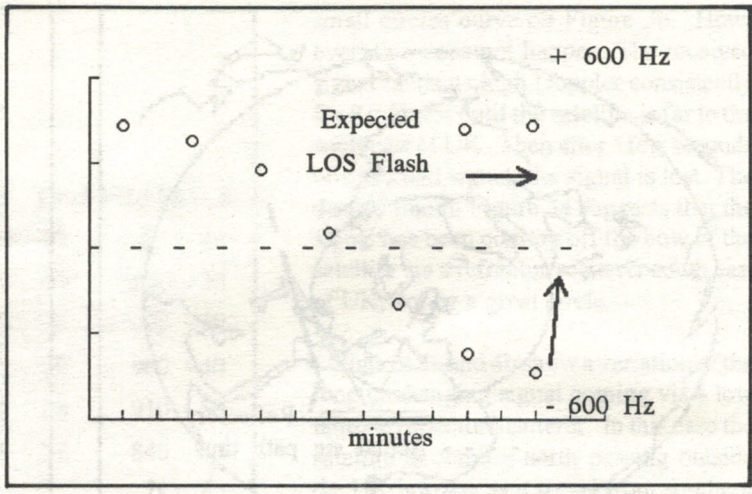


Figure 5b

Normal Doppler Curve, the LOS Flash

In the case described above, we are therefore probably listening to a satellite at LOS when the satellite is at a much lower latitude than the UK, over a region where mirage conditions are not infrequent. Given that at LOS the signal is literally skimming the ocean surface we should not really be surprised if we get a brief episode of super ducting with a consequent sudden short duration large change in doppler frequency.

This Doppler phenomena is not confined to HF satellite signals. It has been heard and reported on VHF/UHF signals (OSCAR 7, mode B) and microwave signals (Dove-OSCAR 17). Although in the narrow passbands employed on most satellite receivers it is difficult to follow the Doppler flash on UHF systems and, those at still higher frequencies, with correspondingly higher Doppler shifts.

Perhaps the best way to visualise what happens in the doppler flash is to return to the visual example of the sunset in still conditions. The sun appears yellow or near white by day, but it goes to orange in color when getting near the horizon, and usually disappears when it has become quite red in color. This reflects a very big gradual reduction in frequency. However, if you are a careful (and lucky) observer, just as the red sun disappears you may see a "green flash". The green flash represents a jump back up in the frequency of the light coming to you just for the last second or so.

More study is necessary before we can be sure how close the analogy is between the visual sunlight green flash and the radio satellite upwards reversal of Doppler. Perhaps it will be better to study this phenomena on VHF or UHF satellites where the effect, sometimes referred to as "reversed Doppler", seems to be more easily observed than it is on the lower HF signals. But be warned that the effect at VHF is quite marked and very disconcerting if you are trying to get the last word out of a narrow band SSB contact.

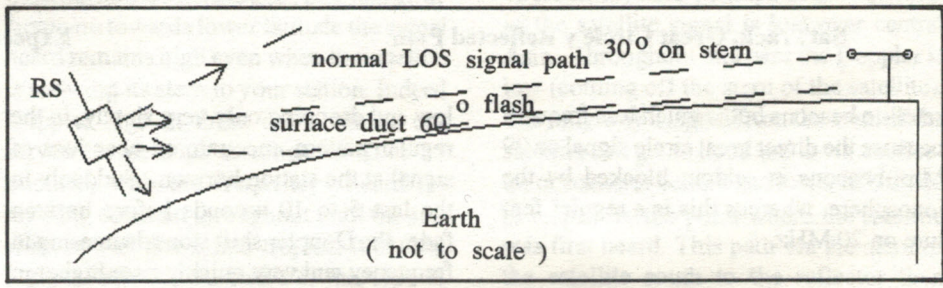


Figure 6

Possible Signal Path of LOS Flash

Two Signals from the Same Satellite

Any user of HF or VHF satellites whose ground station is located above latitude 45N in Europe or 40N in North America, will occasionally hear a direct clear tone signal, and a second indirect signal which is wide band, rough in note and centered on a different tuning frequency than the clear tone. More frequently stations located 10 degrees of latitude further north will hear only one signal, but that signal will be slightly stretched in bandwidth giving it a moderately rough tone. Figure 7 shows the varied station and satellite configurations which can produce these signal types.

On Figure 7 three satellites are shown. Satellite A located over Davis Strait between Labrador and Greenland, is putting a signal into Scotland which has to transit down through the Auroral oval, that active region roughly centered around the Magnetic North Pole , where solar wind plasma is descending vertically into the ionosphere producing vertical zones of strong ionization.. This ionized curtain is in constant random motion, and it imparts to any signal which transits through it a broad band of doppler shift frequency change commensurate with the motion of the curtain. This changes the signal from a clear single note, to a collection of many notes randomly changing their composition and signal strength. Thus, the clear note is lost and a slightly rough tone results. A satellite inside the auroral arc also

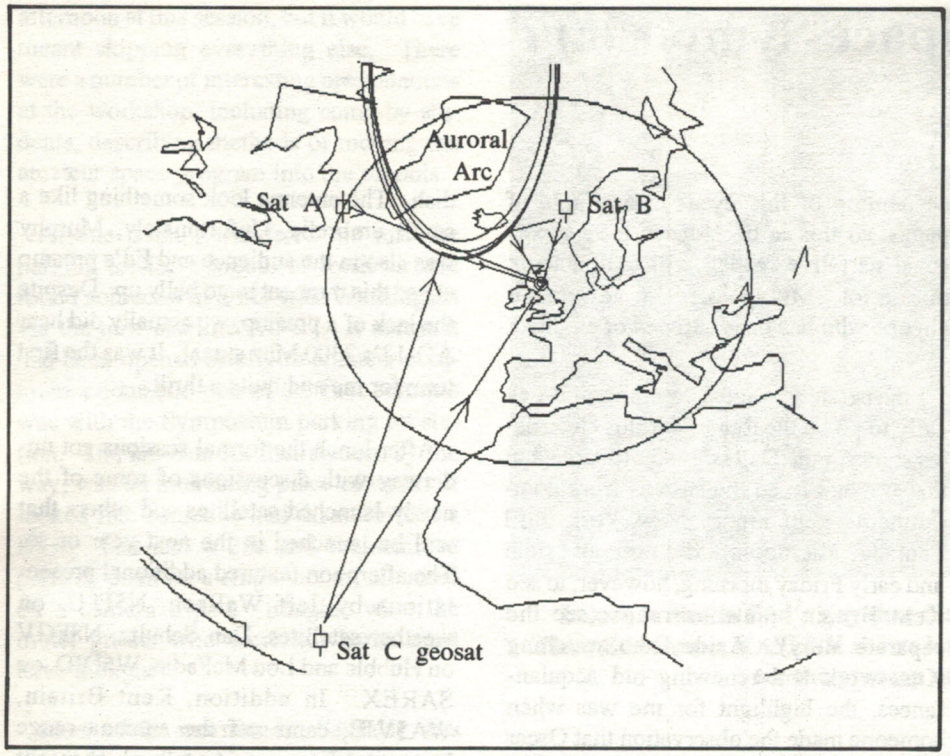


Figure 7

Disturbed and Multipath Signals via Aurora

produces this type of disturbed signal as it transits out through the arc towards Scotland. This type of random Doppler distortion induced by auroral transit is common on signals from satellites north and northwest of UK.

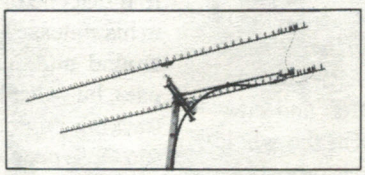
The second example is Satellite B, located just west of Norway. It has a clear path to Scotland unobstructed by Aurora, so a clear signal note is received in Scotland. But satellite B can also put a signal into Scotland via back scatter from the shimmering Auroral curtain. This second signal is usually at a different frequency from the clear note, because it has left the satellite at a different angle on its bow depending on how the satellite is moving with respect to the Auroral curtain. In addition this signal scattered from the aurora experiences wide band Doppler shift. Users of communication satellites such as Fuji Oscar 20 mode JA can often hear a clear version of their signal returned by the satellite transponder, plus a wide band Doppler shifted version perhaps centered 1 or 2 kHz from their clear return signal. It is also the case that when several stations are using the satellite in these conditions most or all of them produce two signal returns , one clear and one wide band auroral tone.

A third example of multiple Doppler shifted signals can occur with a geostationary satellite signal as shown with Satellite C on Figure 7. In this case there is again both a clear direct signal, and a back scattered signal from the Aurora which exhibits wide band Doppler roughness of tone. In the case of both a satellite in the situation shown for satellite B and for satellite C, the aurorally backscattered signal is much rougher in tone than that for satellite A which transitted through the Aurora rather than backscattered from it.

Further Information

The RSGB Space Radio Handbook carries further details and drawings, of how doppler shift is caused and how Doppler anomalies arise and can be exploited to obtain information about the ionosphere.

DOWN EAST MICROWAVE



MICROWAVE ANTENNAS AND EQUIPMENT
• Loop Yagis • Power Dividers •
Complete Arrays • GaAs FET Preamps
• TROPO • EME • Weak Signal • OSCAR •
Microwave Transverters
432 902 1269 1296 2304 3456 5760 MHz

2445 LYK 45el 1269 MHz 20dBi $ 95
1245 LYK 45el 2400 MHz 20dBi $ 79
2455 LYK 55el 1269 MHz 18.5dBi $108
Above antennas kits available assembled.
Add $ 8 UPS S/H
Add $11 UPS S/H West of the Mississippi

MICROWAVE LINEAR AMPLIFIERS SSB, ATV, REPEATER, OSCAR

2316 PA 1w in 18w out 1240-1300 MHz $265
2335 PA 10 in 35w out 1240-1300 MHz $325
3318 PA 1w in 20w out 900- 930 MHz $265
3335 PA 10 in 40w out 900- 930 MHz $330
23LNA preamp 0.7dB N.F. 1296 MHz $ 95
33LNA preamp 0.9dB N.F. 902 MHz $ 95

NEW PRODUCT ANNOUNCEMENTS

New Loop Yagis
1845 LY Loop Yagi 1691 MHz 20dBi $105
945 LY Loop Yagi 3456 MHz 20dBi $ 93
Above antennas assembled and tested

New preamps

13LNA 0.7dB N.F. 12 dB 2.4 GHz $140
18LNA20 0.8dB N.F. 20 dB 1.69 GHz $140
SLNA 1.0dB N.F. 10 dB 2-2.7 GHz $150

New Wideband Power Amplifiers
2370 PA 3w in 70w out 1240-1300 MHz $695
2340 PA 2w in 35w out 1240-1300 MHz $355
2318 PAM 1w in 18w out 1240-1300 MHz $205
Rack mount Amplifiers for repeater use available

NO TUNE MICROWAVE LINEAR TRANSVERTERS

From SHF SYSTEMS a new line of transverters designed by
Rick Campbell KK7B and Jim Davey WA8NLC
Available in kit form or assembled/tested

• 903 1269 1296 2304 3456 5760 MHz
• microstrip filters eliminate tune-up
• 2m i-f, PIN diode switched
• sequencer standard in complete unit
• low profile packaging, mast mountable
• now available, 70cm no-tune transverter and linear amp.

All active equipment - 13.8V

DOWN EAST MICROWAVE
BILL OLSON, W3HQT
Box 2310, RR-1, Troy, ME 04987
Phone: (207) 948-3741 • FAX: (207) 948-5157

The 1993 AMSAT Space Symposium

by John Hansen WAØPTV

The 1993 AMSAT-NA Annual Meeting and Space Symposium was held in Arlington, Texas over the weekend of October 8-10. It was quite well attended, with nearly 200 AMSAT members in attendence, representing more than a dozen different countries.

Some years ago a decision was made to not run concurrent sessions at AMSAT meetings, but rather to schedule the presentations so that everyone could attend all of them. However, in recent years we have fallen far short of this goal. How can we say sessions are not concurrent when in one corner of the lobby James Miller, G3RUH, is discussing the attenuating effects of trees on S band signals while in another corner Stan Wood, WA4NFY is talking about construction techniques for patch antennas, while in another room Tom Clark, W3IWI, is chairing a discussion of the prospects for GPS equipment on Phase 3D? Meanwhile on the "real" agenda, Dan Schultz, N8FGV, is showing some absolutely stunning photos taken by the Hubble Space Telescope. And this is all going on at the same time that Rosalie White, WA1STO from the ARRL is conducting a workshop on ARRL and AMSAT educational activites. On the whole this constant hum of activity is probably a good thing, though it does make it rather hard to keep up. One thing's for certain, you'll never get bored here.

It is virtually impossible to provide anything that vaguely resembles a complete accounting of this event in a couple of pages, so this is necessarily a very personal narrative, which will undoubtedly miss a lot. My apologies in advance to anyone who has been skipped or slighted.

I desperately wanted to come in a day early to go on the tour of surplus electronics shops in the Dallas/Ft. Worth area, but that was not to be the case as work commitments kept me in New York until Thursday afternoon. I did turn out bright and early Friday morning, however, to see Kent Britain's antenna range (see the separate story). Aside from watching Kent work and renewing old acquiantances, the highlight for me was when someone made the observation that Oscar 13 was about to switch to mode S. As luck would have it Ed Krome, KA9LNV, happened to be standing around with a mode S station in a suitcase (see his article in this issue). Where else but an AMSAT meeting could you be standing around with a bunch of folks in a field and just happen to find that one of them has a mode S station in his suitcase? Ed had planned to turn out around midnight to catch the late night pass, but when someone pulled an AO-13 tracking printout out of their back pocket (do these people always carry these things around?) that indicated the satellite was 5 minutes from mode S... well, Ed had an audience and he was off and running.

Ed's station, as you will read, includes a homebrew 2 foot doweling and wire mesh dish. The antenna look something like a small umbrella. Unfortunately, Murphy was also in the audience and Ed's preamp chose this moment to go belly up. Despite the lack of a preamp, we actually did hear AO-13's 2300 Mhz signal. It was the first time for me and quite a thrill.

After lunch the formal sessions got underway with discussions of some of the newly launched satellites and others that will be launched in the next year or so. The afternoon featured additional presentations by Jeff Wallach, N5ITU, on weather satellites, Dan Schultz, N8FGV on Hubble and Lou McFadin, W5DID, on SAREX. In addition, Kent Britain, WA5VJB, came off the antenna range long enough to present a talk which might have been entitled "Antenna Myths" in which he argued that, if done correctly, it is perfectly ok to use metal crossbooms on crossed yagi antennas and to route the coax through the elements.

Running throughout the afternoon on Friday was Rosalie White's educational workshop. I would have liked to spend al

AO-13 Controllers Peter Guelzow, DB2OS and James Miller, G3RUH, made a concerted but unsuccessful effort to "pass" as Texans. (AMSAT-NA Photo

Now Available from AMSAT-NA:

Proceedings of the AMSAT-NA Eleventh Space Symposium and AMSAT Annual Meeting.

October 8-10, 1993

Arlington, Texas

$12/U.S., $17/Canada and Carribean, $20/Europe, $25/Asia

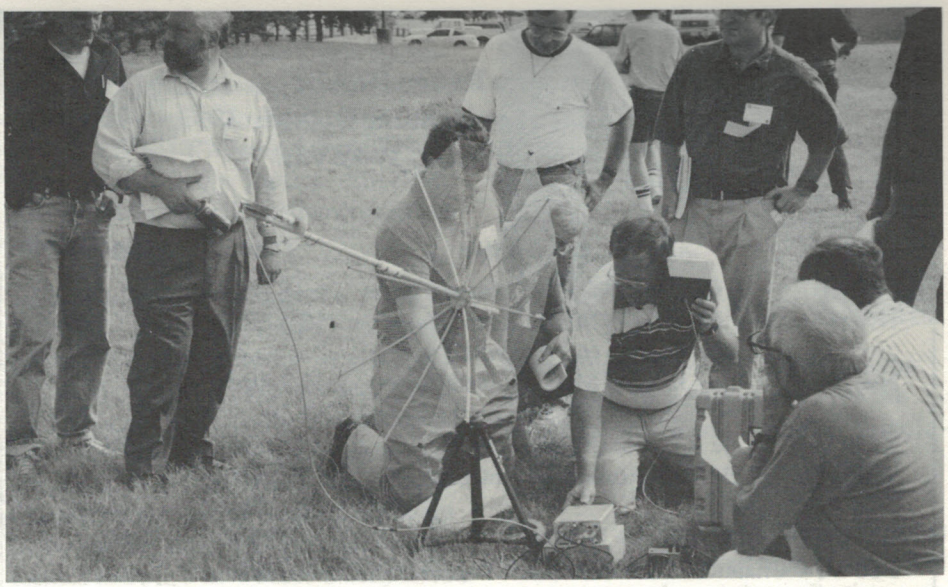
Order from: AMSAT, 850 Sligo Avenue, Suite 600, Silver Spring, Maryland 20910-4703 or FAX credit card info to: 301-608-3410.

afternoon at this session, but it would have meant skipping everything else. There were a number of interesting presentations at the workshop, including some by students, describing methods of moving the amateur space program into the schools.

At one point I wandered out into the parking lot for a breath of fresh air and found someone in QSO with Washington via the new satellite AO-27. It seems it had been opened briefly to amateur communications and one of the first contacts was with the Symposium parking lot station. The antenna for that station, by the way, was an interesting piece of work. It looked like someone had disassembled a KLM 40cx and a 22c and reassembled parts of them on a single boom, mounted on a camera tripod. Imagine what the motel guests who were not hams must have thought?

Most of the morning on Saturday was devoted to extensive presentations on Phase 3D by Dick Jansson, WD4FAB, who discussed progress on the construction of the spacecraft itself, Peter Guelzow, DB2OS, who provided a complete review of the operational aspects of the spacecraft, Stan Wood, WA4NFY, who described the design process of the spacecraft's antenna system, and Tom Clark, W3IWI who outlined the use of GPS on the spacecraft.

The afternoon on Saturday brought a fascinating group of papers. The room was packed at one o'clock to hear James Miller, G3RUH, discuss in detail how the scheduling for AO-13 is handled. James presented a detailed description of each of the tools that is used to decide how to plan spacecraft attitude changes and the mode schedule. As a casual user of the satellite, one of the things that impressed me the most was just how few degrees of freedom he has in planning AO-13's schedule. To a great extent, its schedule is fixed by the need to keep the solar panels illuminated and to provide a small squint angle for mode S activity. It will be a whole new ballgame when P3D is launched. With three axis stabilization it should be possible to keep the panels fully illuminated and the antennas pointed directly at earth for most of each orbit. It will be interesting to see how AMSAT handles this situation when the schedule can be determined more by operational factors than by technical characteristics.



It sure is nice to find a guy that carries a mode S station around with him. Here Ed Krome, KA9LNV shows how to dig the weak ones out of the noise after the preamp dies. (HB9CEN Photo).

Dick Daniels, W4PUJ, presents a plaque to AMSAT-NA President Bill Tynan in recognition of his many years of service to the organization. (KB1SF Photo).

Later in the afternoon Bob Argyle, KB7KCL did a retrospective on the lessons learned from Webersat. It was an honest appraisal of what went right and what went wrong with the Oscar 18 project.

The end of the day Saturday saw two of the best presentations of the weekend. Greg Jones, WD5IVD and Frank Perkins, WB5TPM of the Tucson Amateur Packet Radio group (TAPR) showed the latest version of the TAPR/AMSAT digital signal processing board. This is a long term joint venture that has gone through several incarnations. The plug-in PC board has been abandoned in favor of a stand-alone unit that will be sold as a kit and be signficantly cheaper than any of the all purpose DSP units that are now on the market. What's more, this isn't vaporware, Greg and Frank actually had a unit and showed a video tape of it working. The current schedule calls for the unit to be available later in 1994.

Speaking of cheap DSP, Darrel Emerson, AA7FV, presented a stunning paper explaining how he used a $60 Thunderboard PC sound board to digitize the sig-

Antenna Range Results
AMSAT Space Symposium October 1993
by Kent Britain, WA5VJB

435.1 MHz

Call	Antenna Description	Gain	Axial Ratio
NW7N	20 ele 435X145 MHz Crossed Yagis	11.3 dBd	
NW7N	14 ele 425X145 MHz Crossed Yagis (20 ele with end removed!)	12.5 dBd	
NW7N	20 ele 435X145 MHz Crossed Yagis (End elements respaced on the boom)	13.7 dBd	
KG5OA	15 ele X 15 ele Crossed Yagis	12.9 dBdl	.3 dB
WA5VJB	7 ele Yagi (Reference Antenna)	9.2 dBd	
W5IU	J-Pole	1.2 dBd	
WB6LLO	Quadrifilar	-1.5 dBdl	3.0 dB
Bob's TV Channel 33 seven element Yagi		-8.7 dBd	
1269 MHz	**L-Band**		
W5IU	Helix (WD4FAB Design)	13.7 dBil	2.5 dB
KA9LNV	34 inch .7 f/D dish w/ 3 lb. cof. can feed	9.8 dBi	
WA5VJB	3 lb coffee can (Reference Horn)	6.8 dBi	
WD4FAB	25 turn Ribbon Helix	2.8 dBil	4.0 dB
2400 MHz	**S-Band**		
KA9LNV	34 in .7 f/D dish w/ cof. can feed	17.3 dBi	
WA5DSG	16 turn Helix (James Miller design)	15.5 dBil	.5 dB
W5IU	3 foot dish with 2 1/2 turn helix feed	15.3 dBil	6.0 dB
KA9LNV	34 in .7 f/D dish w/ 3 turn helix feed	14.9 dBil	4.0 dB
WA5VJB	Narda Std Gain Horn (Reference)	13.8 dBi	
W5IU	Down East Microwave 2304 MHz loop yagi at 2406 MHz	13.2 dBi	
KA9LNV	34 in .7 f/D dish with Quadrifilar feed	10.8 dBi	Not Measured
WA5VJB	1 lb coffee can	8.0 dBi	
K5SXK	Singer Ridged Horn	7.8 dBi	
WB6LLO	Quadrifilar # 2 (gain peak on top lobe)	4.3 dBi	
WD4FAB	25 turn Ribbon Helix	1.3 dBil	Not Measured
WB6LLO	Quadrifilar # 1	.8 dBil	1.5 dB
W5NFG	36 turn Helix	-2.2 dBil	6.0 dB
AA7FV	Telescopic Whip	-2.2 dBi	
Bob's Rubber Ducky Antenna		-7.0 dBi	
WB6LLO	Quadrifilar # 2	-9.0 dBi	Not Measured

The range was horizontally polarized. On 435 MHz the reference was dB over a dipole, on 1269 and 2400 MHz the reference was dB over an isotropic source. A truly "Circular Polarized" antenna is rare. CP antennas are shown as dBil or dB gain Eliptical. Gain is measured "Horizontal" then rotated 90 degrees and the "Vertical" gain measured. The difference in gain is call Axial Ratio. In commerical service an antenna with an Axial Ratio of less than 2 dB is considered Circularly Polarized. The small helix feed dish antennas typically showed 4 to 6 dB of gain variation between their Vertical and Horizontal planes.

The phase center of a small helix appeared to be near the last turn i.e. mount the helix with the last turn at the dish focus, not the reflector. Do not expect true circular polarization. Helix antennas can be very difficult to build. Of the 7 antennas using a Helix, only one was truly circular polarized. While the diminsions of a Helix antenna are less critical than a Yagi antenna, great care must be taken in their construction. Do not substitute dimensions or materials from a proven design unless you have the ability to test and modifly your antenna.

Kent Britain, WA5VJB puts the finis ing touches on Ed Krome KA9LNV's homemade, transportable S band dis (HB9CEN Photo

nals from the AO-13 ZRO test to co signals that were actually significantly b low the noise level. The ZRO tests, co ducted by Andy MacAllister, WA5ZI start at level 1, where the transmitted si nal is matched to the strength of the sat lite's beacon. The transmitted signal then cut in half to achieve level 2. It is c in half again for level 3, and so on. Fo lowing level 9, the signal is then cut in ha one more time to achieve level A, approx mately 30 dB below the satellite's beaco Andy says that this is the same level uplink power that could be obtained by HT operating on low power transmittin into a rubber duck antenna. Until Darrel successful effort with his DSP analysis, n one had ever copied this level. No one ha done it since, either. A full explanation how Darrel accomplished this can b found in the Proceedings from the Sympo sium, available from AMSAT Headqua ters.

The highlight of the traditional Saturda evening banquet was an address by Ro Broadbent, G3AAJ, Secretary of AM SAT-UK. In a charming talk, Ron mad a compelling case that we all must becom much more concerned with protectin amateur space frequency allocation Many awards were also presented tha evening including a special plaque pre sented to AMSAT-NA President Bill Ty nan, W3XO, in recognition of hi successful leadership of AMSAT-NA du ing a difficult transition period.

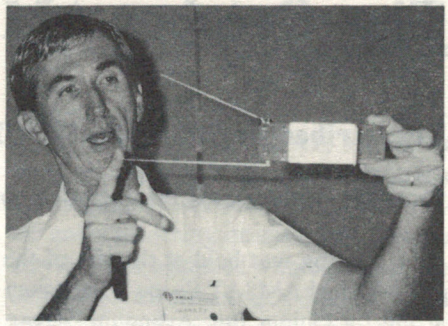
The winner of the Guimont earring co test was also announced at the banque During the weeks before the Symposium

Dave Guimont, WB6LLO, had publicized a contest surrounding a pair of earrings that he had crafted for his wife, Leanore, KA6UCD. The earrings were a pair of quadrifilar helix antennas and the contest was to guess the frequency for which they had been designed. Dave had uploaded a digitized picture of the earrings to KO23 to give people a chance to do a computerized analysis before travelling to Arlington. The winner, Franklin Antonio, N6NKF, was presented with the earrings by Leanore.

Sunday morning began with a field operations breakfast, followed by another set of papers and the AMSAT-NA Board of Director's Meeting (see elsewhere in this issue for the minutes of that meeting). Presenters Sunday included Gustavo Carpignano, LW2DTZ ("VOXSAT- VOice eXperiment SATellite), Gould Smith, WA4SXM ("Tools for the Digital Satellites - Part 1, The Downlink), John Hansen, WAØPTV ("Implementing the PACSAT Broadcast Protocol on Terrestrial Networks"), Ed Krome, KA9LNV ("S Band for the Beginner"), Eric Rosenberg, WD3Q (Non-Messaging Uses of the Store-and-Forward Satellites") Eric Cottrell, WB1HBU ("Microsat Ground Stations"), and Borje Rautio, SM2UHI ("Birth of a Satellite Education Program in Sweden").

I missed a lot of things that went on during the meetings. I didn't get to see several first rate software presentations that went on in the lobby, I missed several of the papers that I really wanted to see because I ended up in some fascinating conversation or other, and, or course, I missed the opportunity to spend big bucks at the surplus stores. But on the whole I learned more in 3 days than I usually learn in 3 months. It was an outstanding set of meetings.

Next year it appears that the meetings will be held in Orlando, Florida. While this may seem to be a long way for many AMSAT members, it may well be easier to get to Orlando than it was to attend the Arlington meetings, since the high volume of travel to Florida that time of year often results in very low airfares. Furthermore, by next year, substantial additional progress will have been made on many of the Phase 3D systems, and a part of that work will surely have been done in Florida. As a result, there will probably be an opportunity to actually see some of what we are paying for. I hope to see you in the sun.



Stan Wood, WA4NFY, describes the redesigned 10 meter antenna for the Phase 3D spacecraft. (KB1SF Photo).

OSCAR and Weather Satellites

Call for FREE Catalog which includes much, much more. Sample publications please send $3.

Software/Hardware:

OSCAR Mode-S 25-dB gain parabolic antenna and feed, 24 x 36 inches (NEW ITEM) ..... $ 55 plus shipping (Call)**
Authorized M² Antenna dealer (call for prices, catalog, etc.) (NEW ITEMs) ..... Call
RealTrak: Satellite Tracking for the PC (Supports Kansas City Tracker and Tuner)) ..... $ 65.00**
WinTrak: the only tracking program designed for Windows ..... $ 49.95**
Kansas City Tracker: for automatic antenna tracking ..... $ 229.00**
Kansas City Tracker/Tuner: adds automatic receiver tuning ..... $ 319.00**
WEFAX Explorer APT weather satellite receiver/demodulator/software (complete system) ..... $ 695.00**
N6RJ 2nd Op: Satellite/DX logging program (best in the field) ..... $ 59.95**
Omni-directional **Quadrifilar Helix** antennas for satellite use ..... Call
Turnstyle APT 137 MHz antenna with preamp built in $150.00**
CD ROM incl. 400 GIF images of Earth (weather/environment) $45.00**
G3RUH P3 Demodulator for OSCAR 13 telemetry (Populated board and kit) $298.00**

Publications:

Having Fun Getting Started on the OSCAR Satellites Book ..... $ 9.95*
Above listed "Having Fun" book **with satellite PC tracking** software ..... $ 12.95*
OSCAR Satellite Report twice monthly newsletter featuring OSCAR Satellites ..... $ 32.00/yr.*
Satellite Operator, monthly features magazine ..... $ 37.00/yr.*
Weather Satellite Report magazine (12 issues) ..... $ 34.00*

*Publication prices USA only. Others call. **Shipping/insurance not included.

R. Myers Communications

PO Box 17108M, Fountain Hills, AZ 85269-7108
Phone: 602-837-6492 FAX: 602-837-6872 VISA/MasterCard

The October AMSAT Board of Directors Meeting

Transcribed by Bill Hook, W3QBC

These are the minutes of the AMSAT Board of Director's Meeting held October 10-11 in Arlington Texas.

The meeting was held at the site of the 1993 Annual AMSAT Space Symposium at the La Quinta Inn, Arlington, Texas. Members of the Board of Directors (BoD) in attendance included Bill Tynan, W3XO, Dick Daniels, W4PUJ, Junior DeCastro, PY2BJO, Andy MacAllister, WA5ZIB and Bob Diersing, N5AHD. Board member, Joe Kasser, G3ZCZ had earlier signified that he would be unable to attend. Others participating at various times included Martha Saragovitz Corporate Secretary, Ray Soifer, W2RS Executive Vice President, Art Feller, KB4ZJ Treasurer, Dick Jansson WD4FAB, VP Engineering, Frank Bauer KA3HDO, VP Manned Space Programs, Harry Yoneda, JA1ANG JAMSAT, Ron Broadbent, G3AAJ Hon. Secretary AMSAT-UK, John Hansen WAØPTV, Editor AMSAT Journal, Keith Baker, KB1SF VP Strategic Planning, Dennis Wingo KD4ETA, SEDSAT-1 Project Manager, Bruce Croskey, WHØI VP Development, Peter Guelzow, DB2OS AMSAT-DL, Paul Williamson, KB5MU AMSAT.ORG Administrator, and Dan Schultz, N8FGV.

Many guests attended the October 1993 AMSAT Board of Director's Meeting in Arlington, Texas. (KB1SF Photo)

The minutes of the May 22-23, 1993 BoD meeting were approved as published in the July/August 1993 issue of the Journal with a note to add to the list of participating Directors the name of Tom Clark W3IWI, who had joined the meeting via telephone from Sweden.

The meeting was opened by Bill Tynan at 0900 Sunday October 10. He asked if anyone had anything they wanted to add to the published agenda. No items were added but a few adjustments were made to accommodate travel schedules.

Bill Tynan noted that each of the items that may require expenditure of money, had a "budget requirements" item included. He said that "by handling the budgetary considerations along with other discussions on each subject, we will be dealing with this often very difficult and protracted item as we go, and thus save a lot of time at the end of the meeting." He also noted that "it will be easier to deal with money requirements while the other aspects of each item are fresh in our minds."

As announced at the general meeting, Bob Diersing was elected by the AMSAT membership to the BoD to replace retiring member Jan King W3GEY. Dick Daniels, Junior DeCastro, and Bill Tynan were reelected to the Board. Joe Holman KA7LDN was elected as Alternate Board Member.

I. Election of Officers

Bill Tynan asked for nominations for the offices provided for in the Bylaws (President, Executive Vice President, Vice President Engineering, Vice President Operations, Secretary and Treasurer). the Incumbents were all reelected and there were no additional nominations. A motion was made to declare the incumbents elected for another year. This was adopted. unanimously. Thus, the officers are Bill Tynan, W3XO President, Ray Soifer, W2RS Executive VP, Dick Jansson, WD4FAB Vice President Engineering, Keith Pugh W5IU Vice President Operations, Martha Saragovitz Secretary and Art Feller, KB4ZJ Treasurer. Ray Soifer again reminded the group that his willingness to serve as a replacement for the President is limited to the 30 days required in the Bylaws. Art Feller announced that he would accept the position of Treasurer for only one more year due to constraints related to his professional responsibilities. Art noted that we should begin a search for a replacement now so that an orderly transition may take place. A candidate with some accounting experience and residing in the metropolitan DC area is preferred. The past year's officers were commended for the excellent manner in which they have served AMSAT.

Bill Tynan noted that the other offices are not provided for in the Bylaws and are created, eliminated and filled by the President as needed. He said that he would take care of these offices following the meeting.

II. Appreciation to Jan King

A unanimous vote of appreciation to outgoing Board member Jan King W3GEY was expressed for his 24 years of outstanding service to AMSAT. Bill Tynan noted that this was the first meeting without Jan among the members of the

Executive VP Ray Soifer, W2RS discusses a point with Peter Guelzow DB2OS while Bill Tynan, W3XO keeps the group focused on the agenda. (KB1SF Photo)

Board. As one of the founders and most visionary members of AMSAT, Jan's presence has been invaluable. All were pleased to learn that we will continue to receive his expert counsel.

III. Auditor's Report

The audit of AMSAT's financial status as prepared by the accounting firm of Verkouteren, Auerbach, Olson and Co. was accepted as written. Treasurer Art Feller described a proposed change in accounting procedure whereby our balance sheet as well as the auditor's report would reflect the current market value of AMSAT's securities rather than their acquisition cost. Martha noted that the auditor's report includes a note which lists the market value of the securities as of the end of the particular year. It was observed that accounting rules do not presently require non-profit organizations, such as AMSAT, to list market values. It the light of this information, it was decided that no change in reporting procedure is required at this time.

IV. Fundraising Results and Projections

Bruce Croskey gave a presentation of his approach to raising funds for Phase 3D. He said that he would like to have biographical information on each of the BoD members in the material he is preparing for prospective donors. He will also include a summary of AMSAT's achievements in supporting educational projects. He stressed his intention to pursue corporate and foundation sources of funds.

Bill Tynan reported on results to date on fund raising from AMSAT members, and on the ARRL campaign. AMSAT's efforts have resulted in raising approximately $200,000. The ARRL campaign has brought in about $185,000. Dennis Wingo volunteered to donate a portion of the income from his software sales as well as some electronic components to AMSAT.

Bill stated that the expenses he had proposed in the 1994 Budget for Fundraising is $44,600. Other than for Phase 3D, income is projected as $8,500. He noted that even though expenditures for fundraising in support of Phase 3D will be charged to Fundraising, all income derived will go to Phase 3D. In other words, he said "we are not diluting Phase 3D income by charging fundraising expenses against it. This represents one financial contribution the organization is making to the Phase 3D Project." The Board members expressed satisfaction with this approach. Furthermore, the fundraising expenditure figure appeared adequate to the Board and Bruce Croskey.

V. Operating Satellite Report

The following spacecraft conditions were reported by Keith Pugh VP Operations: The big news was, of course, the successful launch of four secondary payloads along with SPOT-3 on September 25th.

One of these was POSAT, a dual-use imaging satellite built by a Portuguese consortium. It is understood that its builders are considering its use in the amateur service. It is equipped with both commercial and amateur packages. Thus, POSAT will be given an appropriate designation in the amateur satellite numbering scheme, if it is made available to amateurs and its builders so desire. Ron Broadbent and others will undertake negotiations in an effort to make the satellite available for ham use on at least a part-time basis. Tom Clark noted that POSAT carries a GPS experiment that may have utility in developing software for the Phase 3D satellite, if we can obtain data from it.

Another of the new satellites is ITAMSAT (IO-26) built by AMSAT-Italy with design assistance from AMSAT-NA. Soon after launch, Alberto Zagni I2KBD happily telephoned Tom Clark to report that the project appeared to be a great success. Also on the mission was EYSAT-1 which has been designated AMRAD OSCAR-27. It has both commercial and amateur packages aboard. The satellite was built by Interferometrics Inc. of McLean, Virginia while the amateur package was supplied by AMRAD, an experimentally minded amateur radio group in the Washington, DC area. An impressive demonstration of the capabilities of AO-27 was achieved by relaying greetings from Mark Kanawati N4TPD in Virginia to Symposium participants in Texas via the satellite's voice loop-back mode. AMRAD is expected to soon distribute information on how hams can use AO-27.

The last satellite with an amateur involvement on the mission was KITSAT-B, which has been named KO-25 by its Korean builders. It is very similar to KO-23 in function.

OSCAR-13 has lost its 70 cm downlink transmitter used for Modes L and J. This has resulted in many users migrating to Mode S and experiencing surprisingly good results.

DOVE (DO-17) is operating on the S-Band and new software is being loaded to reactivate it on the 2-meter downlink.

AO-21 is being heavily used in the FM voice mode by a few individuals apparently seeking WAS. Due to the capture effect inherent in FM, some are able to exclude other users by running high power.

UO-11 is back in operation following a recent problem.

The remaining satellites are working satisfactorily. There are 19 amateur radio satellites presently active (including those that are part time). Many of these are primarily digital in nature and more amateurs should be encouraged to use them.

VI. Status of Satellites Under Construction

UNAMSAT

Construction has been completed at the University of Mexico and a launch on a Russian SS-20 is anticipated for December of this year. Tom Clark will assist with the final check-out and Jan King and Harold Price have been testing the software to be used. UNAMSAT will carry a 41 MHz radar to measure the velocity of meteors. This information will then be made available to hams and others via a 2 meter downlink.

SEDSAT-1

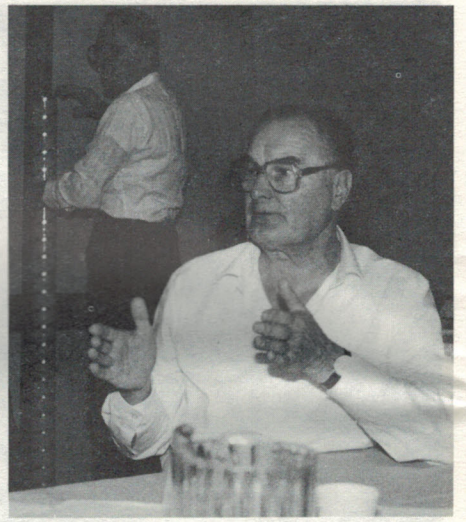
Dennis Wingo reported that SEDSAT-1 being constructed at the University of Alabama at Huntsville is progressing well. This small satellite is to be used primarily by amateurs and will also serve as an educational tool. It is being built at relatively little cost thanks to assistance provided by the Marshal Spaceflight Center and the availability of certain AMSAT engineering designs and donations from industry sources. On October 28, Dennis will travel to California to take delivery on the solar arrays. The TRW Corporation has donated $80,000 to provide these while two other arrays have been provided by the Applied Solar Energy Corp. New nickel-metal-hydride batteries have been provided at cost by their manufacturer and are undergoing cycling tests. Results of these tests will be made available to AMSAT for study. A spare set of NiCd batteries are also on hand.

Funds have been supplied by the NASA-Marshall SFC to pay for accelerometers and a 10-watt Mode A transponder built to AMSAT's OSCAR-7 specifications. This has been completed and is undergoing testing. Efforts are being made to increase the efficiency of the 70 cm transmitter for Mode L. This will provide 9.6-56 kB FSK packet. A 300 bps AFSK HF-packet-compatible beacon has also been funded that will provide a low cost way for all to receive telemetry from the satellite. A launch opportunity in November 1994 on Lockheed's initial launch vehicle is a possibility.

The SEDSAT team has raised $800,000 in contributions and another $100,000 is being solicited. Dennis strongly suggested that it would be in AMSAT's best interest to take greateradvantage of the educational aspects of our activities in order to gain additional funding and prestige for our projects. An approach might be to establish fellowships at universities to assist in design and construction projects that could be supported by donations from industry. In response, our friendly relationship with ESA and our past and present activities in the educational arena were discussed. It was noted that AMSAT-NA might be a more recognizable entity if its activities were centralized at a university as done by AMSAT-UK at Surrey and AMSAT-DL at Marburg. At present we are spread across the continent. Bill Tynan pointed out that we have attempted to recruit new volunteers at universities and various other types of research centers to assume various engineering tasks. He pointed out the our arrangement with Weber State University in Utah, is one example of such AMSAT/university cooperation. Dennis and the SEDSAT team were applauded for their achievements, and Dennis for his counsel.

AMSAT-CE

Tom Clark gave a report on AMSAT Chile. He characterized it as a non-profit amateur foundation created by the Chilean Federation of Radio Amateur Clubs, which continues to refine its structure and goals. The group is working with the University of Chile toward constructing a generic Microsat having high speed digilized voice capability to serve as an amateur "repeater extender" to provide coverage along the length of their country. He has



Ron Broadbent, G3AAJ, representing AMSAT-UK, discusses POSAT at the BOD Meeting. (W4PUJ Photo)

suggested that AMSAT-CE collaborate with AMSAT- Mexico in the construction of the AMSAT-CE spacecraft and to strengthen the alliance between universities and the amateur space program. Tom said that the Chileans plan a meeting with David Liberman for early in June 1994.

PANSAT

The "Petite Amateur/Navy Satellite" has been described as an educational, non-military project of the Naval Postgraduate School in Monterey, CA that will be available for use by amateurs. It is envisioned as a spread spectrum experiment that will likely operate in the 70 cm band. They are currently constructing hardware and some of the details of their project have been made available. After being asked by Bill Tynan to serve as AMSAT liaison to the group, Dick Campbell has been in contact with them to encourage a closer association with the amateur community. Although they have previously had little contact with AMSAT and may have been unaware of the all-volunteer nature of our projects, they are reportedly now looking forward to working with us to help establish PANSAT as a bona-fide amateur satellite. Concerns were expressed by several participants about how this project would fit into the Amateur Satellite Service under FCC and ITU regulations, as well as the need for IARU coordination. It was understood that Dick has made the PANSAT group aware of these issues.

VII. DSP Project

Greg Jones, President of TAPR, presented a report on recent activities in the joint TAPR/AMSAT DSP Project. The basic aim of the project is to develop an affordable and serviceable DSP unit that can be sold to amateurs. Several approaches to a design have been explored over the years and abandoned for various reasons. He noted that a technical description of the current approach is carried in the Proceedings to this year's Space Symposium. He next reviewed the expenditures on the project to date. Each of the two organizations had contributed $6,000 up to February 1991. Bill Tynan noted that the Board had recently voted, via E-Mail, to allocate an additional $1,500 for this project just prior to the meeting. Greg outlined the schedule and additional funding needed for the project. He targeted next fall for availability of the DSP-93 units, as they are now called, for distribution to hams. Beta test units are to be available after the first of the year.

Tom Clark recounted the background of the project and recommended that a 4800 baud modem be included in the suite of software for use by satellite packet users. The issue of intellectual property rights was discussed. Bob Diersing agreed to serve as AMSAT liaison to TAPR for this project.

Bill Tynan said that the proposed 1994 Budget calls for total expenditures of $4,600 for DSP. Income of $5,000 is estimated. This leaves a positive figure of $400. He emphasized that predicting revenues before the product of this nature is brought to market is very difficult. Thus, he said, the $5,000 figure for revenue is a very rough estimate.

VIII. Shuttle Amateur Radio Experiments (SAREX)

Frank Bauer reviewed the past year's activities and missions that included STS-47, -56, -55, and -57. Educational aspects of the recent SAREX missions have been well presented. These have included press and TV coverage of students participating in Portugal, Mexico and France. During the flight of STS-58 thirty contacts are planned and as usual the majority (about 80%) will be with U.S. schools. Art Feller stressed the positive aspect of international participation by schools in that these events may enhance the position of Amateur Radio at future frequency allocation conferences. Frank pointed out that numerous school groups have been simply listening in on the shuttle contacts and that even this passive participation has educational benefits.

It was suggested that summaries of these activities be given to Perry Klein for use in his dealings with federal frequency coordinators.

The interest of some of the present astronauts in amateur radio was noted with the observation that the three licensees on STS-58 are "avid hams". Frank Bauer noted the interest of NASA Director Goldin in the SAREX and shuttle retransmission activities. The Goddard Amateur Radio Club and AMSAT members including astronaut Ron Parise recently participated in a briefing for Director Goldin. Another presentation is planned soon and may offer a real-time contact with the STS-58 astronaut hams and serve as a demonstration of the SAREX and AMSAT programs. Board members offered AMSAT's assistance to the Goddard Club. It was suggested that AMSAT should stress its successes in getting things done "faster-better-cheaper".

John Nickel Asst. VP for Manned Space, will represent AMSAT at NASA Houston during the forthcoming STS-58 mission. This flight will have considerable amateur radio involvement and it is the responsibility of the AMSAT representative there to coordinate these activities including the astronauts' contacts with schools. The question was raised of the cost to AMSAT for the travel and lodging required by its representative during these flights. The amount to date has ranged from zero to $1,400 per flight depending on the length of the mission and the portion contributed by the representative and the distance he had to travel. Four or five SAREX missions are expected to fly in 1994 and the plan is to use the nearest, most experienced member available for this activity. The need to occasionally send a second person to Houston for training in this activity was mentioned.

Ways to enhance the educational content of future SAREX missions were discussed. These may include the transmission of SSTV pictures of land masses below, at the time of a school contact, in order to provide the students with an insight into the geography involved. For example, students might be asked to identify the part of the world over which the Shuttle is flying, from the transmitted picture. Ron Parise and Pat Kilroy are working to interest more elementary school teachers in SAREX activities.

An extensive discussion followed about how to gain additional recognition for AMSAT for its involvement in the SAREX program. It was noted that SAREX will celebrate its 10th year in November of this year. To mark this event, a major presentation is planned for the 1994 Dayton Hamvention that will include participation by astronaut hams.

The opinion was expressed that certain other groups of space enthusiasts are better known than AMSAT although they may have achieved less in the form of tangible results. However they do seem to excel in the arenas of publicity, public affairs and fund raising Although AMSAT and its members have gained a degree of recognition over the years for their technical achievements and support of educational projects, it appears that we need to continue to work at this. Dick Daniels suggested that we renew efforts to interest members of other space-oriented societies in AMSAT's achievements. The demonstration of amateur radio space communications presented several years ago at the Smithsonian Institution by past-president Perry Klein was cited as an excellent example of obtaining positive publicity. Suggestions were made that we offer to contribute to future museum exhibits.

Frank Bauer mentioned concerns of terrestrial operators in various parts of the world regarding frequencies used by SAREX. He noted that changes had been made in an attempt to alleviate difficulties but that no frequency is without some problems. He indicated that no further changes are currently being contemplated.

Discussions were held regarding the 1994 budget for the Manned Space Department. Most of the money is required for travel and living expenses for AMSAT volunteers who support SAREX missions at Johnson Space Center in Houston. A final total of $6,275 was agreed to. Frank Bauer had previously suggested to Bill

Tynan that some revenue might be generated from the sale of books and trinkets. Tynan agreed and asked Frank to begin work on a book to help people become familiar with the techniques of contacting manned space vehicles, both for their own enjoyment and in connection with educational activities. Tynan suggested that $2,000 might be an appropriate target figure for estimated income from such sources.

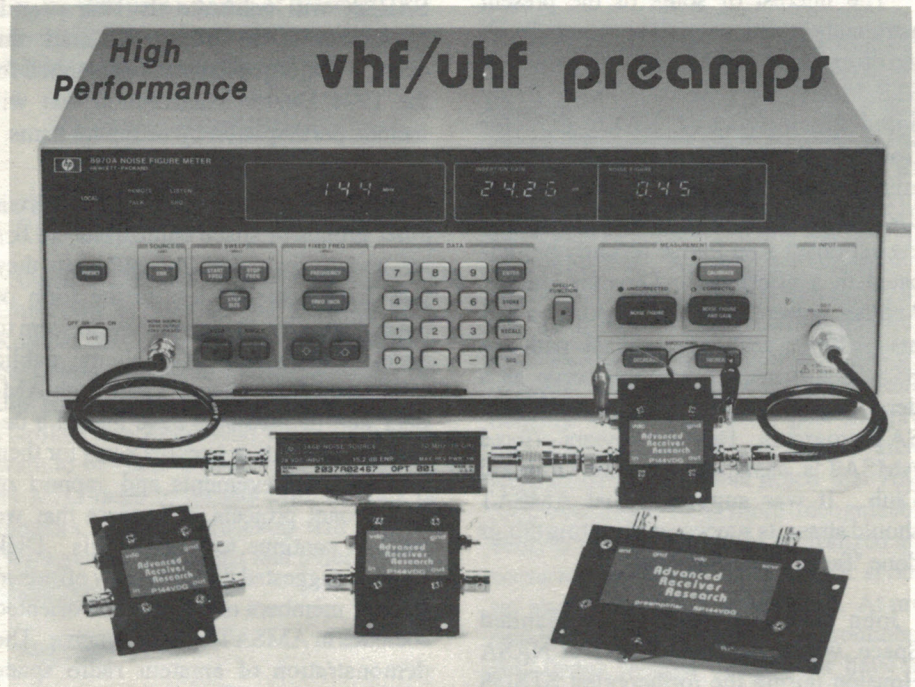
IX. Publications Report

John Hansen outlined his ideas for improving The AMSAT Journal, noting that it is one of our most important activities and is the primary means of maintaining contact with the majority of AMSAT members. Goals to be achieved in future issues include: 1) continued publication of high quality technical papers, 2) an increased effort toward providing information to newcomers and for those with changing interests, a new column titled Groundstation Diagnostics was cited as an example, and 3) more news of current events to fill the need of those who don't have access to the daily updates available from the AMSAT News Service or other newsletters. Buzz Gorsky has recently joined the editorial staff to help fulfill these goals. John said that he considers the present Journal budget adequate but stressed the need for long term planning. This includes frequent updating of the Beginners Guides and other AMSAT publications.

Bill Tynan noted that the proposed 1994 Budget calls for revenue from the Journal of $13,000, most of which is advertising sales, and expenditures of $48,350. He added that, while this seems like a significant deficit, it really isn't because one half of dues are allocated for membership services, including the Journal. One half of projected 1994 dues amounts to about $83,000.

X. AMSAT E-Mail

Tom Clark reported on the organization and progress of AMSAT's worldwide electronic mail system known as amsat.org. Presently there are 685 call signs on the mailbox list representing 36 countries and including 25 organizations. The user interface is maintained on a Sun workstation by Paul Williamson with the assistance of Bryan Kantor who also oversees maintenance of the computer which is located at UC-San Diego. Tom noted that expenditures have thus far been under-budget but that some spending will be required to properly maintain the system and upgrade its capabilities. For example, approximately $1,000 is needed to purchase a one gigabyte hard drive to permit the addition of project file transfer, archival and other functions. It was agreed that funds would be made available to provide necessary maintenance and to purchase the hard drive. The complexities of electronic mail distribution were described by Paul Williamson. The problems encountered by some European users in accessing Internet and costs incurred by users without a direct link to Internet were mentioned. Tom noted the availability of low cost commercial services such as Genie for access to the Internet. A vote of appreciation was afforded to Paul Williamson for his effective administration of the



Receive Only	Freq. Range (MHz)	N.F. (dB)	Gain (dB)	1 dB Comp. (dBm)	Device Type	Price
P28VD	28-30	<1.1	15	0	DGFET	$29.95
P50VD	50-54	<1.3	15	0	DGFET	$29.95
P50VDG	50-54	<0.5	24	+12	GaAsFET	$79.95
P144VD	144-148	<1.5	15	0	DGFET	$29.95
P144VDA	144-148	<1.0	15	0	DGFET	$37.95
P144VDG	144-148	<0.5	24	+12	GaAsFET	$79.95
P220VD	220-225	<1.8	15	0	DGFET	$29.95
P220VDA	220-225	<1.2	15	0	DGFET	$37.95
P220VDG	220-225	<0.5	20	+12	GaAsFET	$79.95
P432VD	420-450	<1.8	15	−20	Bipolar	$32.95
P432VDA	420-450	<1.1	17	−20	Bipolar	$49.95
P432VDG	420-450	<0.5	16	+12	GaAsFET	$79.95
Inline (rf switched)						
SP28VD	28-30	<1.2	15	0	DGFET	$59.95
SP50VD	50-54	<1.4	15	0	DGFET	$59.95
SP50VDG	50-54	<0.55	24	+12	GaAsFET	$109.95
SP144VD	144-148	<1.6	15	0	DGFET	$59.95
SP144VDA	144-148	<1.1	15	0	DGFET	$67.95
SP144VDG	144-148	<0.55	24	+12	GaAsFET	$109.95
SP220VD	220-225	<1.9	15	0	DGFET	$59.95
SP220VDA	220-225	<1.3	15	0	DGFET	$67.95
SP220VDG	220-225	<0.55	20	+12	GaAsFET	$109.95
SP432VD	420-450	<1.9	15	−20	Bipolar	$62.95
SP432VDA	420-450	<1.2	17	−20	Bipolar	$79.95
SP432VDG	420-450	<0.55	16	+12	GaAsFET	$109.95

Every preamplifier is precision aligned on ARR's Hewlett Packard HP8970A/HP346A state-of-the-art noise figure meter. RX only preamplifiers are for receive applications only. Inline preamplifiers are rf switched (for use with transceivers) and handle 25 watts transmitter power. Mount inline preamplifiers between transceiver and power amplifier for high power applications. Other amateur, commercial and special preamplifiers available in the 1-1000 MHz range. Please include $2 shipping in U.S. and Canada. Connecticut residents add 7-½% sales tax. C.O.D. orders add $2. Air mail to foreign countries add 10%. Order your ARR Rx only or inline preamplifier today and start hearing like never before!

Advanced Receiver Research

Box 1242 • Burlington, CT 06013 • 203 582-9409

amsat.org service and to Brian Kantor for maintenance of the hardware as well as software support.

XI. Phase-3D Progress Report

Dick Jansson announced that much progress has been made since the previous BoD meeting. The call for volunteers to machine small parts has had a good response, although additional help is needed. Flight versions of the special heat sink bottom covers are being fabricated. Several small meetings were held this past summer in Marburg to discuss specific projects including the JAMSAT video camera and deliberations with ESA regarding the structure's interface. Another meeting will be held soon in Munich to discuss RF equipment and to consider ways of reducing the spacecraft's mass by approximately 60 kg without reducing its structural integrity. Ways of reducing the craft's mass to be meet ESA's 500kg limit were discussed. After subtracting the mass required by the F2624 cylindrical launcher section (SBS) used to enclose the spacecraft and fuel requirements, the assembled spacecraft must have a mass of no more than 216kg. The bare spaceframe is 52kg. Only about 164kg is available for all other equipment. Replacing the nickel cadmium batteries with the nickel hydrogen (NiH) type would reduce their mass but the latter would be more expensive and require ordering now, while there is one immediate source of NiCad cells now in cold storage. Dick asked for help in finding contributors to help finance the batteries and solar arrays. Ron Broadbent agreed to explore the possibility of finding a source of suitable batteries in the UK.

Dick Jansson reported that good progress was made in Marburg during the summer toward constructing the engineering model spaceframe. A schedule has been developed for continued fabrication efforts at Weber State University during the coming academic year. Eleven students plus a full-time intern from the University of Stuttgart will be working in Utah as part of a work-study program to build the flight model spaceframe.

The final design and fabrication schedule of the F2624 SBS has yet to be decided with ESA. Stan Wood, with help from the Florida Institute of Technology, has been making good progress with antennas including reducing their mass. Surface area is being reserved for GPS antennas.

One quote for solar panels in the amounts of $225,000 for 12.3% cells and $229,000 for 14.3% cells has been received. Alternative sources and fabrication techniques for solar arrays under consideration were also discussed. It was noted that gallium arsenide cells are more costly to purchase and install than silicon types. Cells must be ordered by summer 1994. Payment for assembling them into arrays will come later. A donation of solar panel substrates valued at $36,000 has been received from the Thermal Equipment Company. Arrangements were made to acknowledge this tax-deductible contribution. Bill Tynan said that a fundraising effort aimed specifically at raising funds for the purchase of solar arrays is under consideration. Dick Daniels reported on the status of the hypergolic propulsion system and the need to assign the responsibility for providing the electronic module known as the "liquid ignition unit".

Tom Clark reported on the progress being made in the development of the GPS and master clock systems.

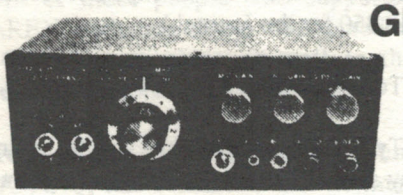
Dick Jansson emphasized that a choice of a site for the final integration facility must be made soon. He said that a small warehouse with approximately 12,000sq.ft. would be appropriate. He favors a location in the Orlando, FL, area because some of the of the critical personnel live in the area and there is a likelihood of finding other talented volunteers, some retired, there as well. He cited the fact that there are 43 AMSAT members living in the Orlando area. He added that other possible sites include Marburg Germany, Weber State University in Utah and the University of Alabama at Huntsville. Jansson also stressed that recruitment of a Facility Manager should begin soon. He emphasized that this is one of the major slots which must be filled. A retired person with managerial experience and a record of getting things done would be ideal. This person could also serve as a Project Manager keeping things on track and the volunteers organized and focused on the tasks at hand. Dick stressed that personal concerns made it important that he acquire qualified help in managing the team and helping with the design drawings.

A discussion ensued as to the necessity for liability insurance for individuals and facilities followed with the suggestion made that the ARRL insurance plan for radio clubs might be able to offer coverage at a reasonable cost. Bill Tynan took an action item to look into this and other insurance possibilities.

Bill Tynan noted that, after consulting with Dick Daniels and Dick Jansson, he

AMATEUR TELEVISION

GET THE ATV BUG



New 10 Watt Transceiver
Only $499

Made in USA. Value + Quality for over 25 years in ATV. . .W6ORG

Snow free line of sight DX is 90 miles - assuming 14dBd antennas at both ends. 10 Watts in this one box may be all you need for local simplex or repeater ATV. Use any home TV camera or camcorder by plugging the composite video and audio into the front phono jacks. Add 70cm antenna, coax, 13.8 Vdc @ 3 Amps, TV set and you're on the air - it's that easy!

TC70-10 has adjustible >10 Watt p.e.p. with on xtal on 439.25, 434.0 or 426.25 MHz and properly matches RF Concepts 4-1110 or Mirage D1010N-ATV for 100 Watts. Hot GaAsfet downconverter varicap tunes whole 420-450 MHz band to your TV ch3. 7.5×7.5×2.7" aluminum box.

Transmitters sold only to licensed amateurs, for legal purposes, verified in the latest Callbook or send copy of new license.

Call or write now for our complete ATV catalog including downconverters, transmitters, linear amps, and antennas for the 400, 900, and 1200 MHz bands.

Tom (W6ORG)
Maryann (WB6YSS)
VISA, MC, COD

P.C. ELECTRONICS
2522 Paxson Lane, Arcadia, CA 91007

(818) 447-4565
M-F 8am-5:30pm pst.

had arrived at a 1994 Budget expense figure for Phase 3D of $431,700. This high number reflects the fact that 1994 will be a very important year in the construction of this spacecraft. Many expensive items must be purchased and a lot of metal cutting and bending will take place. He added that revenue, in the form of donations, is estimated at $300,000. This includes the approximately $200,000 ($185,000 to date) raised by the ARRL and approximately another $100,000 that AMSAT should be able to raise from its members. This leaves a shortfall of $131,700, some of which will come from Phase 3D money raised but not yet spent. The revenue does not include any large sums which might come from industry or foundations. Naturally, more revenue will be needed before the satellite is completed, tested and launched. The actual launch cost is still an unknown.

Bill Tynan voiced the need to better define the management of the Phase 3D Project. He noted that some recent events, such as the confusion over the inclusion of a 2 meter transmitter, have not been beneficial to the successful completion of the satellite. He said that he would go anywhere and meet with anyone in an effort to insure the success of the Project. In recognition of recent improvements in understanding, a resolution was introduced and passed unanimously to commend Ron Broadbent for his work toward improving understanding between the various groups working on the Phase 3D project.

XII. Long Range Planning

Keith Baker, who had been appointed VP for Strategic Planning by Bill Tynan in July, gave a presentation of his approach to answering the question of "where does AMSAT go after the completion of Phase 3D?" He stated that he feels that the first thing that should be done is to conduct a survey using a representative sample of the membership to learn their interests, resources and expectations and to identify a new generation of engineering talent. He suggested that a team of 5-7 knowledgeable persons under his leadership evaluate responses from 200-400 randomly selected AMSAT members and then make recommendations about what should be undertaken in the future. He further indicated that he believes that an incentive will be needed to encourage recipients to return questionnaires, and solicited ideas.

Once collected and analyzed, the survey results should provide a reasonable basis for planning future objectives and programs. Tom Clark noted the need to include the opinions of persons with exceptional foresight and vision among the final evaluators so that the wants of the membership can be translated into realistic objectives.

Bill Tynan emphasized that, as a Board Member and one who has previously brought up the need for long range planning, Joe Kasser be included in this activity. Results of earlier survey efforts are to be examined to learn how concepts have changed with emerging technologies. Dick Daniels suggested including among the goals of the study, taking a close look at how AMSAT is evolving and what its role may be in the future. A motion was made and passed that AMSAT shall undertake a strategic planning program under the leadership of Keith Baker and that necessary resources be provided to support this effort. A sum of $1,000 was approved to start this project under the budget category of Administration.

XIII. IARU Amateur Satellite Coordination

Bill Tynan reaffirmed our organization's commitment to coordination of amateur satellite frequencies through mechanisms established by IARU. He cited the fact that two U.S. built satellites (EYESAT (AO-27) and SEDSAT) had been coordinated as an illustration of this commitment. In both of these cases, the satellite builders had been advised by AMSAT-NA of the need for such coordination. A resolution was introduced and passed unanimously to put AMSAT-NA on record as continuing its commitment to such coordination.

XIV. Management of Investments

In response to a request from the Treasurer, it was decided that, henceforth the BoD will provide the Treasurer with explicit directions about the purchase and sale of securities held by AMSAT. Art said that this is, in part, necessary to avoid any possibility of the appearance of conflict of interest arising as a result of his specific employment.

XV. Interferometrics Agreement

Bill Tynan provided the background and read applicable portions of the text of the December 1988 agreement between AMSAT and Interferometrics regarding the licensing to them, for commercial - non-amateur exploitation, of certain features of the Microsat design. In May 1993 Interferometrics proposed a modified arrangement for their payment of fees to AMSAT that they felt would be advantageous to both groups. Bill expressed his support for adopting the revised agreement. Dick Daniels suggested adding a clear definition of a "base year" to be used in calculating cost escalation. Bill Tynan was given the Board's support for negotiating details as to a specific base year and escalation factor. The BoD voted to accept the revised agreement with Tom Clark abstaining.

XVI. Budget

Since most of the budgets for the major areas had already been discussed, this agenda item did not require a great deal of time. Bill Tynan reviewed the total figures as follows:

Total Projected Income: $631,700

(This includes a projection of $55,000 for dues from new members and $111,000 from renewals.)

Total Projected Expenses: $761,990

(As noted earlier, most of this is for Phase 3D. Other major expenses include $48,350 for the Journal.)

Total Shortfall: $130,290

Tynan commented that "while having any shortfall, much less such a large one, does not normally represent good fiscal management, it is explainable because 1994 must be a heavy expenditure year for Phase 3D. Our positive operating figures for the past several years were, in part, because of funds raised for Phase 3D, and which had not yet been spent. Now they must be spent."

XVII. "Ata-boys & Ata-girls"

Jack Colson was commended for his organization and hosting of a day-long seminar recently presented by Jan King

describing the philosophy and realities of building small satellites. It was suggested that this excellent presentation be made available to other satellite builders in the form of videotape and/or by publication of Jan's notes.

Jan King was similarly commended for his presentation of the material plus all of the other contributions he had made to the amateur satellite program over the years.

Martha Saragovitz was commended for her many years of service to AMSAT with a particular observation that she, more than any other single person represents our "corporate knowledge".

Past Director Harry Yoneda, JA1ANG, was thanked for coming to the U.S. specifically to attend this meeting (as he did in 1991 and 1992) and for contributing his experience and insights.

Dick Jansson was commended for his continued hard work in the design of the Phase 3D spacecraft.

John Hansen was congratulated on his fine start as Editor of the Journal as well as his earlier work in a supporting role.

Paul Urie was commended for his picking up the reins as Journal Editor in a crisis situation.

Paul Williamson, Brian Cantor and Tom Clark were commended for the fine operation of amsat.org.

All of those people who supported SAREX, including those who served at JSC during missions as well as the telebridge stations, were commended.

It was noted that Bruce Rahn, WA9ANQ, has concluded that he must resign as a Microsat command station. Bruce was thanked for this work as well as being of invaluable help coordinating activities at Dayton.

XVIII. Other Matters

The Board was sorry to hear of the illness of past Director Pat Gowen, G3IOR, and sent best wishes for a speedy recovery.

Junior De Castro PY2BJO asked that the following be read into the record of the meeting:

Because Junior's command of English, while infinitely greater than mine of Portugese, is such as to make it difficult for some of us to readily understand his meaning; I have edited his actual wording somwhat, while endeavoring to convey his essential meaning. -- Bill Tynan W3XO

Men, Their Ideas and Their Responsibilities

Once again we meet to start a new phase of our lives and to discuss the future of amateur satellites. It is clear that all of us are extremely happy to be here. Some for their re-election to this Board of Directors (that is my own case), others for their election for the first time.

But I must mention that we have a lot of hard work ahead of us. It is the responsibility of our generation to prepare the means for Amateur Radio to literally take to the skies in the next century. It is also our generation's responsibility to impart to the new generation the traditions of Amateur Radio, especially its potential for promoting peace.

We must keep in mind that Amateur Radio's frontiers are not geographical, political, religious or racial. We must never establish any sort of such frontiers within the amateur community.

We must always remember to respect, and carefully analyze all ideas presented; and never to reject them out of hand. But, if after careful analysis, an idea is shown to be unworkable or non-productive, it is our obligation to explain the reasons to the person offering it - as well as to offer alternatives. Never, should we simply ignore an idea.

Anyone closely involved in Amateur Radio these days, is aware that a major problem is to obtain the necessary financial support to permit carrying out new and ambitious projects such as the creation of a low cost amateur satellite network. Thus, wouldn't it be appropriate to look to new alternatives such as the establishment of an "amateur radio world foundation". Such a foundation would be active in all countries, primarily to collect donations and contributions and to disburse the resulting funds for worthy amateur radio projects.

The foundation could advertise in various amateur and non-amateur magazines around the world, including such publications as Popular Science, Astronomy, Sky and Telescope, Scientific American etc. In addition to advertisements, major effort would be placed on writing articles for many different publications describing the various the foundation's projects and highlighting their status and problem areas. Management of the foundation would be in the hands of an international team, under the surveillance of a council consisting of representatives of the various amateur satellite organizations throughout the world.

In November, 1991, when I first took a seat on the AMSAT Board of Directors, I suggested an idea of this type. I based my thoughts on the example set by Carl Sagan and the Planetary Society, which has amassed a membership of hundreds of thousands including people of all ages; and has raised over a million dollars annually. I questioned why we can't do the same.

Although my suggestion met with general approval at the time, nothing has transpired in the intervening two years. I still believe that the establishment of such a foundation should be a goal for AMSAT. I am sure that it would result in many new memberships, both amateur and non-amateur. Some of the non-amateurs are certain to join our ranks in the years to come.

A detailed analysis of AMSAT's Financial Report for the year ending December 31, 1992 shows a balanced condition. On the other hand, if one looks at the funding needed to carry out our major project [Phase 3D], there are not sufficient funds to complete it, much less embark on any new projects.

Time is passing. We must take the right course. We cannot simply sit with our arms folded.

XIX. Conclusion

The meeting was concluded at 14:30 pm Monday October 11. It was not officially adjourned as various items are handled via E- Mail as the need arises.

Heard on the Downlink

by John Hansen, WAØPTV

This issue is rather short of space due to the coverage of the Space Symposium and Board of Director's Meeting. As a result, this will be an abbreviated version of the column that usually appears in this space.

Rods Revisited

Ron Long, W8GUS, who suggested the source of fiberglass rods mentioned in the last issue sends along a warning that you should be extremely careful when removing these rods from their shipping containers. It seems that they are covered with small slivers of fiberglass. Wear gloves and use caution.

PG for the Mac

The problem of finding a way to operate PG on a Macintosh computer has been solved, at least for those of you who own AEA DSP2232's. It seems Andre, ON4AIG, has released a new version of PG called PG_AEA.EXE. Ron Parsons, W5RKN, reports that it works great with SoftPC Pro for the Mac. Of course, this only solves the problem for those of you using the DSP2232, but at least progress is being made!

If you are a Life Member Outside the U.S.....

If you are an AMSAT-NA Life Member living outside the U.S. and you would like to receive this Journal by first class mail, it is possible to do so. However, it will be necessary for you to pay the additional mailing cost, which amounts to $15/year U.S. Contact AMSAT Headquarters.

TAPR to Discontinue PSK Modem

The latest issue of the *Packet Status Register*, the journal of the Tucson Amateur Packet Radio (TAPR) group, announced that after the current stock of PSK modem kits are sold no more would be available. The TAPR kit has been sold for just over $100 and was, by far, the cheapest way to become active on FO-20, AO-16, WO-18, and LO-19. PSK equipment has also been included on a number of newer satellites, including ITAMSAT (IO-26). Furthermore PSK capability has also been planned on some yet to be launched satellites such as UNAMSAT-1 and Phase 3D. While it has been argued by many that 1200 baud PSK is pretty much obsolete when compared with 9600 baud FSK, it is fairly certain that 1200 baud PSK capabilities will be in orbit for many years to come.

With the demise of the TAPR kit, the remaining ways to obtain PSK capability are signficantly more expensive. PacComm has available the PSK-1, which can be wedded to a standard TNC-2, but the cost is more than double that of the TAPR unit. PSK is also one of the modes available on either the L.L. Grace or AEA DSP units, and will also be available on the forthcoming TAPR DSP unit. These boxes do far more than simply 1200 buad PSK, but they are also substantially more expensive.

New LUSAT Software Loaded

The long awaited new software for LO-19 has reportedly been uploaded to the satellite. In addition to assisting those who are attempting to run automated stations, the new software now means that it will be possible to use the same version of PB as on AO-16, UO-22 and KO-23.

AMSAT-NA 1992 Financial Statement Available

A document entitled "Radio Amateur Satellite Corporation Financial Statements for the Years Ended December 31, 1992 and 1991" which was produced by the accounting firm of Verkouteren, Auerbach, Olson & Company, is now available from AMSAT-NA Headquarters. It consists of 11 pages of financial statements outlining the financial condition of the Corporation. To obtain a copy, send a 9 x 12 inch self addressed, stamped envelope with .75 of postage to Headquarters.

AMSAT BoD Elections

Voter turnout was heavy in the recent AMSAT Board of Directors Elections. The winners were:

Bill Tynan, W3XO

Richard Daniels, W3PUJ

Junior Torres De Castro, PY2BJO

Robert Diersing, N5AHD

The alternate is Joseph Holman, KA7LDN.

STRAIGHT KEY NIGHT

January 1, 1994

As you know, ARRL has for many years sponsored Straight Key Night on New Year's Eve and New Year's Day; it is expected to do so again in 1994. On New Year's Eve, 1972 (January 1, 1973 UTC), a few of us on the AMSAT 75-meter net decided that we would try to combine the best of the old and the new in Amateur Radio by operating in Straight Key Night on what was then the brand-new communications satellite, AMSAT-OSCAR 6.

Since then, proud brasspounders have kept the tradition going by operating CW on OSCAR using straight keys for at least a little while on every New Year's Day(UTC) when there's been an OSCAR to work. You're most cordially invited to join in the 22nd annual celebration. It's entirely informal and unofficial; there are no rules, no scoring and no need to send in a log. Just call CQ SKN in the CW passband segment of any OSCAR satellite between 0000 and 2359 UTC on January 1, 1994, or answer a CQ SKN call from another station.

This year, we're changing things alittle: we'll also count QSOs made via the oldest, largest and most reliable communications satellite, OSCAR Zero, otherwise known as the moon. AMSAT didn't build it, but we can adopt it! Of course, all SKN operating must be done with a straight hand key. Just as in the ARRL HF version of this event, we're conducting a search for the OSCAR SKN operator with the best fist. Please send in a nomination of someone you worked; we'll announce the winner or winners via packet bulletin. Last year's winners were KB6A, W6HDO and W8JAQ. Nominations maybe sent via packet to W2RS @ WA2SNA.NJ.USA.NA, from Europe to W2RS @GB7HSN.#32.GBR.EU, via Internet to w2rs@amsat.org, or by mail to my Callbook address. CU SKN and 73, Ray W2RS

Development of a Portable Mode S Groundstation

by Ed Krome, KA9LNV

Editor's Note: This paper was first presented at the 1993 AMSAT Space symposium in Arlington, Texas.

Satellite Mode S is a fascinating mode of operation. With its 2401 MHz downlink, it is leading edge technology, yet accessible to any satellite buff willing to try it. Its popularity has been increasing rapidly, with new stations appearing almost daily. The crew up there is friendly and always eager to help new ops get started and swap info about what works best. It's quiet and uncrowded. Since mode S operation on AO13 requires the same uplink (70cm) as does mode B, most active satellite ops already own most of the gear required. 2401 MHz is a downlink, requiring only an antenna, preamp and downconverter. Many ops have quite good success with only a single 8 foot long loop yagi; a tiny antenna indeed. Mode S is a fun band.

The attendant small antennas, always the most cumbersome part of a satellite station, brought up the question of just how small a portable station could be put together.

First Attempts

This project has been evolutionary rather than revolutionary and will continue to be so. To date, it has been through several iterations, each getting more transportable and more satisfactory. My first attempt at a portable downlink was to lug my home station around. This consisted of a single loop yagi, a preamp, an S band downconverter and a Kenwood TS-430S transceiver. It worked, but was not very convenient or pretty. And that assemblage didn't include any uplink gear at all. Since the Kenwood can't run full duplex, a completely separate 70 cm transmitting arrangement was required. The whole mess started to resemble packing for a family vacation. There must be a better way.

Antennas

A particularly vexing part of the original station was the antenna. I built an 8 foot loop yagi so it could be taken apart into two 4 foot sections. But it still was rather a pain to transport and could be easily damaged, and really didn't provide the level of performance I desired.

Although I had used loop yagis for several years, I had always been interested in dish antennas; in particular, the concept of a stressed dish. For those not familiar with stressed dishes, there is a rather amazing physical principle that says that if you anchor a thin beam at one end, then pull the other end at a right angle to the beam, under very small deflections, the bend that the beam will assume is parabolic! Cool. That's mechanical engineer's talk for a rather incredible phenomenon. So, I built one.

The original stressed dish was an assembly of 18 inch long 5/16 oak dowel rods radiating from a drilled oak hub, with a 3/4 inch dowel rod center post glued through the middle. The end of each dowel was tied to a common point on the central dowel rod with 25 pound test "casting" fishing line. This line is braided Dacron and doesn't stretch, so once you get things adjusted correctly, they will stay put.

The feed was simplicity itself; a short helix built from #12 house wire. G3RUH has published details on how to make small helix feeds on Internet and in the AMSAT Journal[1]. I have built versions from 3 to 6 turns and all work fine. The completed antenna frame was covered with 1/4 inch mesh hardware cloth, which had been cut into pie-shaped segments and wired to the dowel arms of the dish with some overlap. I connected a GaAsFET preamp directly to the helix feed. This assemblage was then put up on my tower, nestled between a pair of 432 yagis.

Performance was simply amazing. I had never been able to extract data from the AO13 S band beacon before, but now it worked fine. QSO's were armchair copy. This was some antenna. But it still wasn't exactly portable. In fact, it was quite the opposite. Just trying to carry this multi-dimensional thing, bristling with sharp edges of wire mesh, up the tower was quite a challenge. After all, I do like to hold on with more than one hand when I climb.

The design basically consisted of 8 wire mesh wedges suspended between 8 short dowel rods. Well, why not put the dowels in the middle of the wedges instead of at the edges? Then each 5/16" dowel with its attached mesh wedge became a single piece plugged into a hole drilled radially in a wooden hub. The trick was to get the wedges so they assume the desired shape and support each other. So I first plugged 4 wedges into the hub at 90 degree intervals. Then I pulled each of the 4 wedges into shape with fishing line. Then I inserted the remaining 4 leaves. Since the first 4 were stressed to shape, they were out of the way of the next 4. Then these 4 were each pulled into shape with the fishing line. Since each wedge was cut with 3/4 inch of overlap to its mating part on each edge, the second group of 4 tended to mate well with the first set and hold a pretty good shape. It even looked like a dish. Of course, this didn't make a perfect dish, but small deviations to true form (1/10 wavelength, or 1.3 cm (1/2 inch)) mean almost nothing to the overall performance of the dish. Even fairly large deviations only cause the performance to deteriorate a few db, and in practice, really don't seem to have much effect. Just to stabilize the whole thing, I used a few pieces of wire to tie the edges of the wedges together.

After assembling the dish surface itself, I slid the feed into place and secured it with a hose clamp. Instant antenna! Ah, but is it portable? Sure is. When the ribs with their attached wire mesh wedges are removed from the center hub, they lie flat. The wedges, ready to go, can be easily stacked in the bottom of a suitcase and take up less than an inch of height. The center hub and 3/4 dowel center post are carried separately. To make the antenna easier to assemble in the field, I screwed very small eye hooks into the end of each radial arm. Each rib-forming piece of fishing line was tied solidly to a hole in the center mast on one end and to a small S-hook on the other.

After the initial effort to tie off the right length of line to get each rib bent to the correct shape (which should be done with the bare rib alone before the mesh is attached), reassembling is simply a matter of plugging the dowel rod and mesh wedge into the hub and hooking the S-hook to the appropriate rib eyebolt. You can mark or color code the ribs and lines to insure correct reassembly.

Be careful when you build your dish, but don't be too critical. It is amazing how far you can deviate from true form and still have a functional dish. I have built small dishes with f/d ratios from .5 to .85 and all have performed satisfactorily.

Receiver

Once the antenna problem was solved, the next most cumbersome piece was the HF transceiver. Nice piece of gear, but a bit much for field work. And not full duplex, either. A review of amateur literature for the past few years turned up a variety of interesting receiving ideas. Small superhets, direct conversion, even a regen or two. I have some experience with direct conversion receivers, having built a few NE602 based designs. They are simple, compact and functional, but don't offer much dynamic range and are rather easy to crush. Recognizing that this receiver would be part of a full duplex system and would be in close proximity to a fairly powerful transmitter (even if it was on a different band) sounded like a less than satisfactory situation.

A different approach has been published by Rick Campbell KK7B (developer of the "no-tune" transverters that are so popular on the microwave bands)[2,3]. This approach recognizes that the weakest part of a direct conversion receiver is not the RF section, but the mixer. His design work placed a large emphasis on proper mixer termination and really low distortion audio amplification. Campbell has published two versions of his direct conversion approach, one a "straight" approach called R1 and the second a "single signal" approach, called R2.

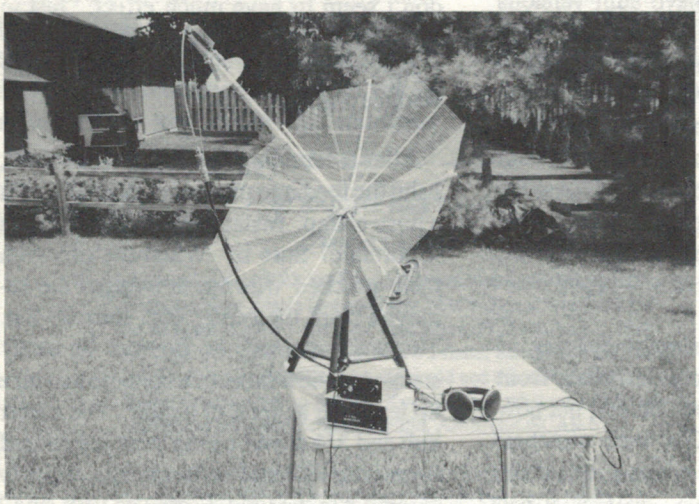
The straight version mixes the RF with the Local Oscillator in a double balanced mixer, which is terminated in a diplexer filter (which passes the audio bandwidth and terminates everything else in 50 ohms). The diplexer is followed by bandpass filters and 100 dB gain of very low distortion audio. This design has one rather odd (typical of direct conversion) characteristic; you can hear each signal twice, once on each side of zero beat. For SSB, you tune the one that sounds like something human. It works great, but it does make for a lot of signals in the passband. This setup appears well suited for the less crowded bands.

Campbell's second approach is a direct conversion receiver that gives only one signal instead of mirror images of the same signal. This scheme is quite a bit more complicated, and essentially uses 2 identical mixer/diplexers followed by audio phase shift amplifiers which are identical except for a 90 degrees of phase difference between them. The 2 identical mixers are fed RF from a splitter from the antenna. Each mixer is fed a separate local oscillator (LO) signal split from a single LO, but 90 degrees out of phase to each other. The 90 degree shifted signal is referred to by a magic word; "quadrature". These phase shifts result in unwanted image cancellation and reception of only a single signal. If you want to switch to the opposite sideband, you reverse one of the phase shifts. Sounds complicated but it works great. The articles are must reading.

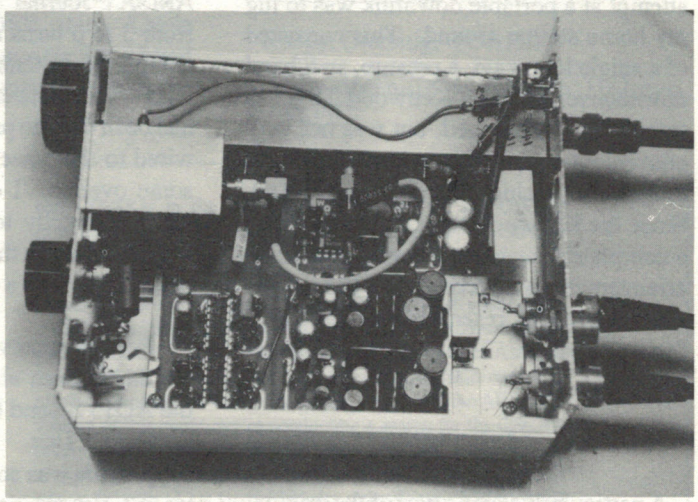
Since Campbell's articles showed some really small radios, I gave them a try. Fortunately, Campbell has beautiful circuit boards available for reasonable cost. So after debating the merits of dead bug breadboarding, I ordered one of each board.

The boards are quite compact and easy to build. One really unique thing about this type of receiver is that there are no frequency-sensitive components on the circuit board. A board is suitable for use on any frequency within the frequency range of its mixers.

My initial thoughts were to build the unit as a direct conversion receiver for 2.4 GHz. Wow, 2400 MHz to audio in one step. Then a small problem reared its ugly head. To receive a signal, you have to provide the board with an LO equal to the frequency you want to receive. To tune it,



Portable mode S receiving station with 34" stressed dish, helix feed and preamp, downconverter and direct conversion receiver (the c-clamp on the back of the dish is a counterweight). (KA9LNV photo)



2 Meter Direct Conversion Receiver, showing R2 board, 140 Mhz crystal oscillator (small box on right), 4.8-5 Mhz VFO with hetrodyne mixer, and LO amp. Phase shifter network is externally mounted and not shown. (KA9LNV Photo)

you tune the LO. And to use the single signal version, you have to split and phase shift the LO by 90 degrees. Tuning the LO could be done with a crystal oscillator based UHF source mixed with a stable VFO, but accurately phase shifting a 2.4 GHz signal started to sound rather daunting. Scrap that one.

So I took the easy way out. I built the single signal direct conversions receiver, with a tunable LO and phase shifter for 144 MHz (see Figure 1). This was used as the IF behind a normal 2.4 GHz to 144 MHz downconverter. Campbell published a hetrodyne type tunable LO in QST[4]; I built something similar, dead bug breadboard style and it worked fine. A note on phase shifter construction: build a tunable version (such as a Wilkinson divider followed in one leg by a tunable shift network) since in order to adjust the image suppression of the receiver, it is necessary to go back and forth between adjusting the audio phase shift and the LO phase shift. And it makes a huge difference to the performance of the radio. I used very closely matched components (1/2 %, matched with a borrowed RLC bridge) and the unit worked with little adjustment. But, when I started tweaking the phase shift components, unwanted sideband suppression rapidly improved from db to at least 40 dB.

The first time I connected the small homebrew dish with preamp, Down East Microwave downconverter, and the 2" x 5" x 6" receiver, I heard AO13 mode S just fine! QSO's on small homebrew gear are quite a kick. This is a satisfactory mode S portable station.

And Smaller Still...

Although my interests are really in homebrew gear, I tried a piece of commercial equipment in order to make things even smaller. I borrowed an SSB Electronic 2.4 GHz downconverter from W9FMW, and mounted it directly at the feed of the dish. Since the SSB converter has a GaAsFET front end, it worked nicely without an external preamp. This replaced the preamp and downconverter previously used. Mounting the DEM downconverter directly at the dish feed will also provide satisfactory results, but it really needs the improved noise figure and gain of a preamp.

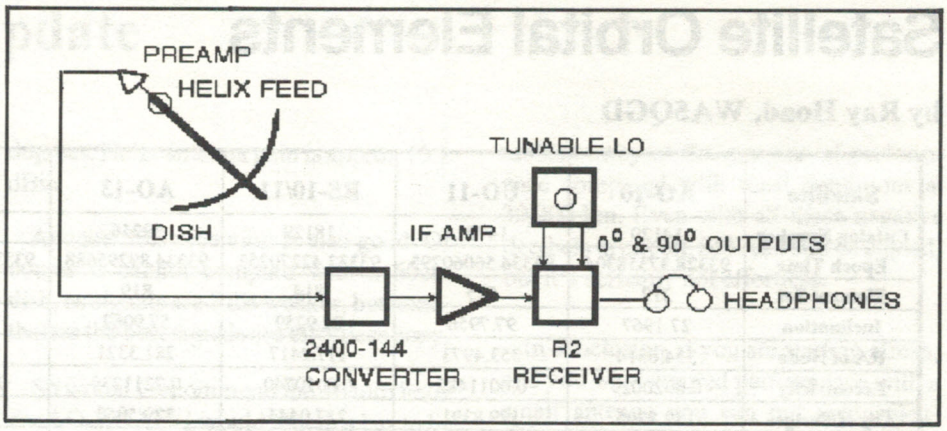


Figure 1: 2400 Mhz Portable Receiver

The Next Step

As I said at the beginning, this is to be an evolutionary project. The next stage will be to eliminate the downconverter and build a direct conversion receiver for 2.4 GHz that mounts at the dish feedpoint and has a headphone output. Since, as previously mentioned, the biggest problem with this approach is the need to phase shift the LO, a better bet is to use the R1 receiver board and tolerate the image signals. Though the population is increasing on mode S, there aren't usually enough stations to make this a severe handicap. Although this device has not yet been built, I am collecting parts for it and expect to have some results in the near future. It will be published in the AMSAT Journal.

Transmitting

Transmitting on 435 MHz was handled in a similar method to reception. KK7B has also published and supplies circuit boards for a tiny phasing-type SSB/CW exciter[5]. Like the R1 and R2 receivers, the basic board is not frequency specific. Frequency of operation is determined by the LO. As with the single signal R2, two LO signals are required with a 90 degree phase shift between them. The board was easy to build; the tunable LO somewhat more complicated. I used a 448 MHz crystal controlled oscillator (I happened to have a 100 MHz crystal that functioned nicely at its 7th harmonic of 112 MHz. Two doublers and an amp provided 10mW (+10 dBm) at 448 MHz. This was mixed with a buffered FET VFO (identical to the one used on the 144 MHz LO but operating at 12 MHz) to provide 436 MHz output. Filters and amps got rid of the unwanted mixing product and provided +13 dBm for the splitter/phase shifter.

With this LO arrangement and its built-in MMIC RF amp, the exciter provides a massive 3 mW of good sounding SSB or CW on 436 MHz. Getting to required power levels can be approached from a number of ways. I used a little 70 cm amplifier I built a few years back that uses an MRF 911 to drive an S-AU4 "brick" hybrid amplifier[6]. This provides a few watts output to a commercial amplifier. Although I use a Mirage D24 (2 watts in, 40 watts out) with an input attenuator (use what you've got, right?), this driver amp will drive a Mirage D1010 to 100 watts out. Another approach would be to use a brick such as the M57786M to replace the MRF 911/S-AU4 amplifier. While I am not familiar with this device beyond a catalog listing, this brick is rated to produce 7 watts out for 2 mW in.

Generally, an uplink system is full of tradeoffs. The requirement is that some minimum EIRP is required to access the bird. This can either be done with a small antenna and large amount of RF power or a large antenna and less power. Do you want to carry a larger antenna or a larger amp? If the intended use of this station will require battery power as in a Field Day installation, secondary power sources are heavier than antennas. So use a small amp and a larger, breakdown antenna. I built a 13 foot long K3RIW-type 70 cm antenna that breaks down into 4 sections. This is pretty small and is quite rugged. Use of 40 watts uplink power is usually adequate. Note that this antenna is single plane polarized. Though this is detrimental in terms of performance, it is a lot easier to

(continued on next page)

Satellite Orbital Elements

by Ray Hoad, WA5QGD

Satellite	AO-10	UO-11	RS-10/11	AO-13	FO-20	AO-21	RS-12/13
Catalog Number	14129	14781	18129	19216	20480	21087	21089
Epoch Time	93328.37358304	93334.56060295	93332.42270253	93334.89295688	93330.50118171	93334.52703634	93335.60629654
Element Set	212	615	814	819	611	372	616
Inclination	27.1967	97.7956	82.9259	57.9062	99.0189	82.9438	82.9186
RA of Node	354.6814	353.4973	117.2417	281.3321	155.8314	289.7212	157.9722
Eccentricity	0.6020029	0.0011482	0.0010740	0.7211239	0.0541157	0.0034068	0.0028484
Arg of Perigee	132.8205	179.8391	217.0444	329.5060	78.7761	279.0086	300.8203
Mean Anomaly	296.5509	180.2820	143.0089	3.4438	287.3633	80.7210	59.0141
Mean Motion	2.05877703	14.69091713	13.72327034	2.09727727	12.83222138	13.74529132	13.74031015
Decay Rate	.00000006	.00000200	.00000059	-.00000293	-.00000019	.00000084	.00000062
Epoch Rev	7855	52114	32237	4185	17813	14229	14150
Satellite	**UO-14**	**AO-16**	**DO-17**	**WO-18**	**LO-19**	**UO-22**	**KO-23**
Catalog Number	20437	20439	20440	20441	20442	21575	22077
Epoch Time	93334.69642848	93334.68970974	93334.66327841	93334.21540152	93334.69648230	93334.67727514	93335.44100612
Element Set	915	715	715	716	715	415	312
Inclination	98.6046	98.6123	98.6134	98.6128	98.6137	98.4566	66.0879
RA of Node	57.0601	58.0868	58.3203	57.8916	58.5780	47.9847	334.0117
Eccentricity	0.0011889	0.0012249	0.0012311	0.0012863	0.0013153	0.0007826	0.0005948
Arg of Perigee	55.3459	55.8918	55.5998	57.2334	55.4957	156.5425	336.7167
Mean Anomaly	304.8840	304.3434	304.6342	303.0100	304.7459	203.6132	23.3555
Mean Motion	14.29806558	14.29863405	14.30000807	14.29978366	14.30070867	14.36868808	12.86282019
Decay Rate	.00000066	.00000056	.00000062	.00000060	.00000055	.00000086	.00000000
Epoch Rev	20122	20123	20124	20118	20126	12457	6135
Satellite	**KO-25**	**IO-26**	**AO-27**	**FY-1/2**	**MIR**	**UARS**	**POSAT**
Catalog Number	22830	22826	22825	20788	16609	21701	22829
Epoch Time	93334.73062882	93335.65645330	93335.66121621	93339.47904126	93335.61195375	93332.63061551	93289.11726978
Element Set	215	215	214	821	8	416	204
Inclination	98.5750	98.6753	98.6748	98.8533	51.6183	56.9840	98.6763
RA of Node	46.7010	48.2666	48.2617	0.7053	98.3478	242.6493	2.0610
Eccentricity	0.0012513	0.0010130	0.0009506	0.0014839	0.0005473	0.0005839	0.0010043
Arg of Perigee	41.6119	68.0262	67.0884	188.6689	48.6088	92.2745	184.4594
Mean Anomaly	318.6010	292.2022	293.1315	174.3362	311.5306	267.9904	175.6498
Mean Motion	14.28019103	14.27695161	14.27592650	14.01384510	15.58761518	14.96170835	14.27975951
Decay Rate	.00000063	.00000067	.00000054	.00000689	.00006745	.00004494	.00000072
Epoch Rev	937	950	950	16657	44522	12090	286

Portable Mode S Groundstation

(continued from page 27)

carry an antenna that breaks down and stores flat than one that looks like a porcupine. Alternatively, you could simply plan to remove the second set of elements from a circularly polarized yagi for transportation. This still needs original thought.

And So...

This article is really intended more to whet a person's appetite than to be a construction article. I do hope that it will help inspire ham experimenters to try new modes and ideas in improving the state of our interests. I intend to continue to evolve the mode S groundstation. Stay tuned!

Notes:

1. J. Miller, "A 60cm S-Band Dish Antenna", The AMSAT Journal, Mar/Apr. 1993, pp. 7-9

2. R. Campbell, "High-Performance Direct-Conversion Receivers", QST, Aug, 1992, pp. 19-28

3. R. Campbell, " High-Performance, Single-Signal Direct-Conversion Receivers", QST, Jan. 1993, pp. 32-40

4. R. Campbell, "Single Conversion Microwave SSB/CW Transceivers" QST, May, 1993, pp. 29-34

5. R Campbell, "A Multimode Phasing Exciter for 1 to 500 MHz", QST, Apr. 1993, pp. 27-31

6. E. Krome, "A High Performance, Easy to Build 432 MHz Transverter-Part 2", QST, Sept. 1991, pp. 18-21

S-Band 16t Helix Update

by James Miller, G3RUH

The July/August issue of *The AMSAT Journal* contained some notes waggishly entitled "Small iS beSteSt". I described a 16 turn helix that I had built for Oscar-13 use. Anyway, recall that my goal was "the smallest possible antenna that will let me decode the PSK telemetry beacon error-free at apogee with a low noise (0.6dB) pre-amp". Please remember that.

As I said then, it worked exactly as expected on the beacon, and remarkably well on SSB and CW. But my testing was done at 30,000 km range, and I would have to wait until September 1993 to evaluate it at 43,000 km. This I have now done.

I am happy to report that at APOGEE, reception of the beacon is exactly as expected; just adequate for error free decoding of the PSK. So my goal was met. For the record, Eb/No = 13 at R=43,000, Squint = 0 deg and elevation above 25 degrees. Helix antenna gain is approx 15.2 dBic.

Apogee SSB reception is also good. Of course it cannot compare with a 60cm dish, as signals are 5 dB weaker, but nonetheless the best signals are effortless copy.

So would I recommend the 16 turn helix for AO-13? Yes I would, but this has to be qualified. Remember it is supposed to be the SMALLEST practical antenna for AO-13 and there are bound to be situations when it falls short of ideal. At 30,000 km, as a fun antenna that is so small you have to watch out you don't step on it yes, try it. The beacon is huge, and SSB no problem.

But at 43,000 km signals are 3 dB down compared with 30,000km; at horizon elevations the noise comes up another 3 dB, and if the squint angle happens to be 20+ degrees, then there is another 3 dB down the tubes! So any combination of these nibbles away at the margins of performance compared with ideal conditions at 30,000 km. Even with all these negative decibels in circuit, SSB can still be copied, but it's certainly not effortless.

In conclusion, if you are starting afresh, and you want assured performance with a small antenna you can put inconspicuously on the mast along with the other arrays, then my recommendation (for AO-13) would be to go for a 60cm dish with the converter at the feed. See Amsat Journal March/April 1993 and Oscar News, Amsat-DL Journal, Amsat VK Newsletter, CQ-DL.....etc. My life, do I not get paid for this stuff?

Having said all that, a 16 turn helix antenna will be OVERKILL for P3D! AO-13's EiRP is only 5 watts. P3D will be somewhere in the region of 5-20 kilowatts, i.e. 30-36 dB more powerful. Did I say rubber duckie?

New converters for OSCAR & ARSENE

UEK-2000 S — **High performance S-band converters for both satellites**

Based upon the requests of the advanced satellite user, we have developed a new "easy to use" converter with these features:

- Super-low noise HEMT-input RF amplifier with a N.F. of ‹ 0.6 dB
- Overall converter N.F. of 0.8 dB, 1.0 dB for mast-mounted version
- 2-pole Helical filter for superb front-end selectivity
- GaAs-Fet second stage preamplifier
- Surface mounted Schottky Double Balanced Mixer (DBM) with 144 MHz IF
- Very stable x-tal oscillator with filter coupled multipler stages
- Teflon-PCB & microwave SMD construction
- Voltage feed via coaxial cable or via separate line
- Different models available for either OSCAR Mode "S" or the new ARSENE
- Mast-mounted versions feature: SS-Hardware, N-Connectors & weatherproof construction
- Non mast-mounted versions are available with neu-silver boxes & SMA connectors
- With a tuneable receiver (144 – 191 MHz), one converter can cover both OSCAR & ARSENE

For more information
on this and over 100 exciting products from SSB Electronic including the new AIRCOM PLUS (10.3 mm) low-loss-semiairspaced 50 Ohm coaxial cable

please contact:

SSB ELECTRONIC GmbH
Panzermacherstr. 5
58644 Iserlohn/Germany
Phone ++49 / 23 71 / 64 54
Fax ++49 / 23 71 / 6 75 93
EUROPE, ASIA, AFRICA

SSB Electronic

SSB ELECTRONIC USA
124, Cherrywood Drive
Mountaintop, PA 18707, USA
Phone ++1 / 717 / 868-5643
Fax ++1 / 717 / 868-6917
AMERICA, AUSTRALIA

AMSAT-OSCAR-13 Eclipses from 05Apr89 to 27Apr89

by Graham Ratcliff, VK5AGR

Editors Note: This article first appeared in the AMSAT Australia Newsletter, Number 49, 30 Apr 89, and as the title indicates the telemetry data was gathered in April 1989. However, the information presented is timeless and could have been gathered during any period of eclipses. One reason for presenting the article is to illustrate the interesting things you can do by observing the AO-13 telemetry.

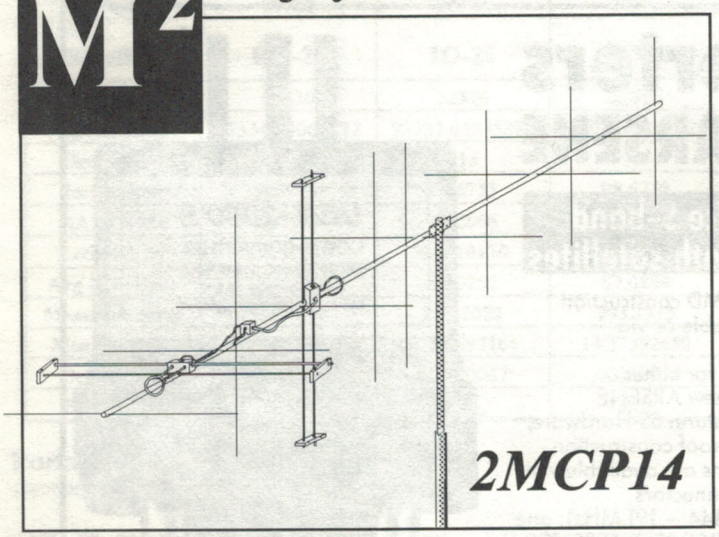
The OSCAR-13 operating schedule was changed on 15Mar89 to accommodate the change in attitude to the nominal 210/+5 and in light of the fact that AO-13 would be subject to solar eclipses from 05Apr89 to 27Apr89 between approximately MA 35 and MA 70. We have had many queries as to why the transponder OFF time was so long, i.e. MA 0 to MA 100 so we decided to have a look at the PSK telemetry on 15Apr89 from 12:08:10 to 16:03:56 UTC which equates to 5 minutes before the start of an eclipse until 2 hours and 20 minutes after the end of the eclipse.

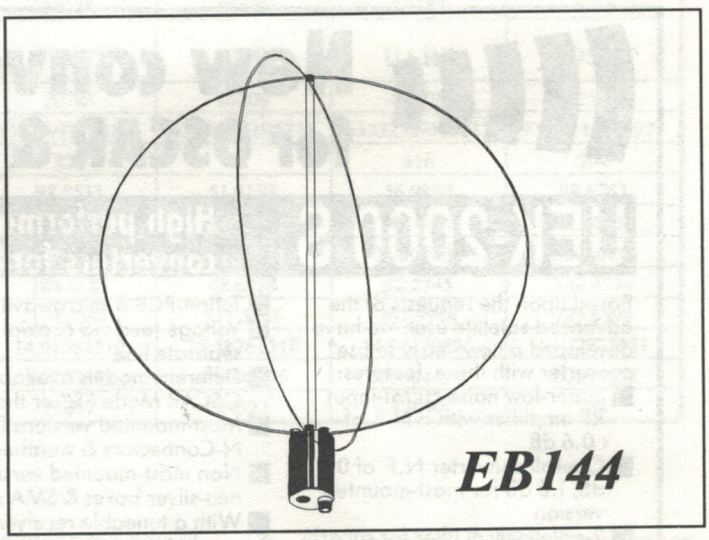
Fig 1 is a graph of the data collected during that period showing the changes in temperature of the Main Battery, the Battery Control Regulator, the Nutation Damper in Arm#3 and Solar Panel #3. Also shown is the Voltage on the 14V Bus and the Battery Charge Current. Each point on the graph represents a value obtained in a 30 second interval. The magnitude of the changes allow us to appreciate at once how severely AO-13 is affected during and after each solar eclipse.

Fig 2 is an engineering drawing of AO-13 which shows the relative locations of the various modules within the spacecraft so that you can see how the 'wave of cold' passes from the outside of the spacecraft to the center of the structure.

Some interesting observations can be made from the graphs in Fig 1. For instance, as expected, the outside of the spacecraft gets colder much more quickly than the inside. At the end of the eclipse Solar Panel #3 gets to as low as -43C and rapidly increases in temperature the instant that the spacecraft exits the eclipse while the Main Battery, which is located near the central core of the spacecraft, gets down to only 0C at the end of the eclipse and continues to fall to a minimum of -3.5C some time after the eclipse has ended and returns to only -1.8C 2 hours and 20 minutes after the end of the eclipse. The Battery Control Regulator, which is located centrally inside Arm #2b, basi-

M² Enjoy consistent, reliable satellite communications!





The 2M-CP14 is a circular polarized antenna with match and gain optimized between 144 and 147 MHz for the serious OSCAR user. Computer design keeps spurious side lobes small for optimum S/N ratios and forward power. Sealed, weather-tight driven elements give years of trouble-free performance - a perfect partner to the M² circular polarized 436CP30.

See the Sept. QST review and find out just how well this versatile omnidirectional performer accesses high and low orbit satellites (inc.137 MHz weather). The compact EB144 is also surprisingly effective for mobile, nets, contests, and field day operations. Polarity is horizontal at the horizon, RHC overhead. For UHF, there's the companion EB432.

VISA

WATCH FOR OUR NEW S BAND ANTENNA SYSTEMS...COMING SOON!

M² 7560 N. Del Mar Ave., Fresno, CA 93711 (209) 432-8873 FAX 432-3059

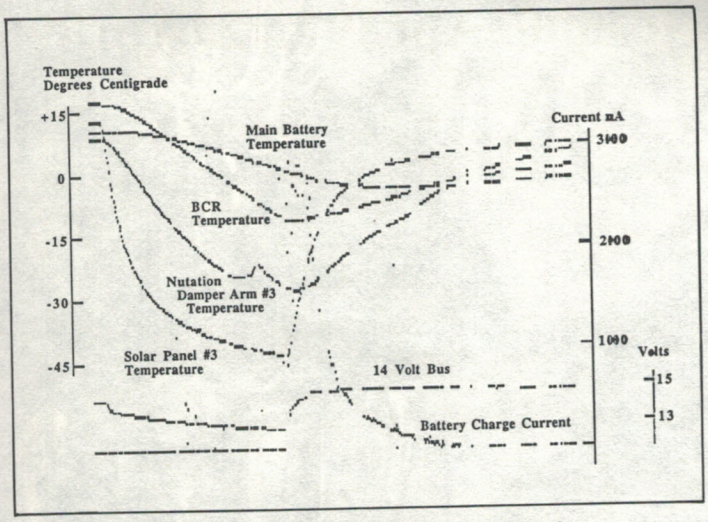


Fig 1: **AMSAT OSCAR AO-13 Telemetry Analysis 1989 April 15 from 12:08:10 to 16:03:56 UTC**

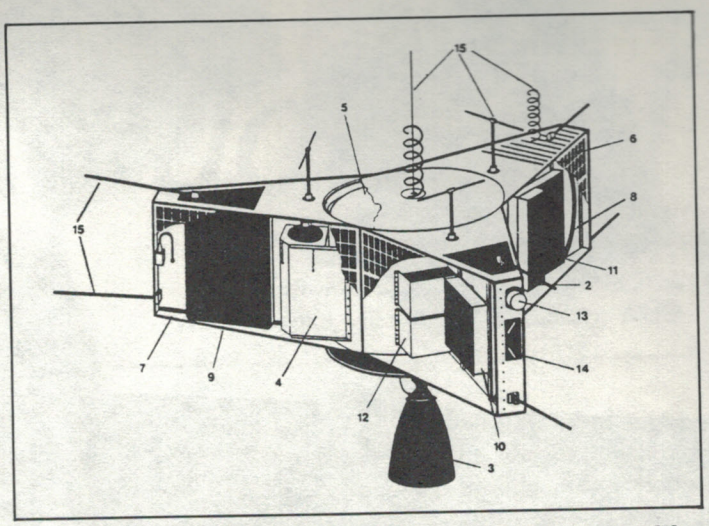


Fig 2: AMSAT OSCAR-13 showing Solar Panel [6], Nutation Damper [8], Battery Charge Regulator [10] and Auxiliary Battery [12]. The main battery is just above the auxiliary battery.

cally follows the Solar Panel temperature drop but to a much lesser degree, which is expected due to its position inside the spacecraft.

The Nutation Damper, located just inside the end of Arm #3, shows an interesting phenomenon, in that it closely follows the drop in temperature of the Solar Panel but at about -24.6C the temperature all of a sudden rises to -22.1C over a several minute period before falling again to a minimum of -28.4C just after the spacecraft exits the eclipse.

The Nutation Damper is an evacuated tube containing, according to pre-launch data, a mixture of 60% glycerin and 40% water. Chemical tables predict the 60/40 mixture would have a freezing point of -33.6C and a 50% mixture would freeze at -22C. This data is from Lange's Handbook of Chemistry, Editor John A. Dean, Thirteenth Edition, McGraw-Hill Book Company, page 10-76. They state that their values are those reported by Bosart and Snoddy in the Journal of Industrial Engineering Chemistry 19, 506 (1927) and Lane, same journal, 17, 924 (1925) but modified by adding 2 degrees F to all temperatures below 0 degrees F in accordance with the suggestion of the Proctor and Gamble Co.

Apparently the rise in temperature observed in the AO-13 telemetry data is due to an exothermic reaction occurring near the freezing point. And the data may indicate that the actual glycerin content is somewhat different from the nominal 60%. This is an interesting example of the little tidbits that await the telemetry explorer! We would like to thank Dean, AL7CR, for supplying the chemical data.

Also note that the high charging of the battery occurs before the Main Battery temperature reaches its minimum of -3.5C. Also it is worth noting that the 14V Bus actually falls as low as 12.8V during the eclipse and rises to 14.9V after the eclipse. The 14V Bus prior to the eclipse was steady at 14.4V.

As this article has tried to illustrate there is a wealth of interesting information which is freely accessible to anyone equipped with a 400 baud PSK modem and the appropriate decoding software such as P3C.EXE.

AMSAT-NA MEMBERSHIP FORM

Name: _____

Call: _____

Address: _____

_____

State/Prov: _____ ZIP/PC: _____

VISA/MC #: _____

Exp. Date: _____

☐ New ☐ Renewal

Membership is $30/year U.S., $36/- Canada, $45 elsewhere, (all payments in U.S. $) which includes six issues of *The AMSAT Journal*. 50% of membership dues are directly allocated to spacecraft development. Members receive discounts on software purchased from AMSAT. Life Membership is $600.

Mail to: AMSAT
850 Sligo Avenue, Suite 600
Silver Spring, MD 20910-4703
or
FAX to: (301) 608-3410

Join AMSAT today and help keep Amateur Radio in Space.

Low Cost Oscar 10/13 Satellite Uplink
Mode B and S transmitting converter

uses your existing 10 meter radio (all modes)
28 Mhz in at 10 mw max - 435 Mhz 15 to 20 watts out
assembled and tested, only $249 plus $6 shipping
10 watt to 10 mw 28 Mhz attenuator and cable $25
write for details on low cost Mode B and S downlinks

$5 will be donated to AMSAT for each unit sold

Dale Henkes, AB4NJ
1916 Plumb Ridge Rd
Knoxville, TN 37932 U.S.A.

Put yourself in the winner's circle

with the PK-232MBX multi-mode controller.

The PK-232MBX sets the pace for multi-mode controllers. While the competitors are racing to catch up, the PK-232MBX surges into the lead, winning more contests and providing the best value of any multi-mode controller on the market today.

Leave the competition in the dust—with the highest quality filters available (seventeen-pole effective filtering), the PK-232MBX pulls signals out of the noise better than any other controller.

Satisfy your drive for variety with PACTOR, Packet, AMTOR/SITOR, Morse, RTTY (Baudot/ASCII), WEFAX, NAVTEX, and TDM modes.

You won't spin your wheels trying to identify a signal. Our revolutionary SIAM™ technology automatically identifies the incoming signals, switches the PK-232MBX to the recognized mode, and starts displaying the data.

PACTOR, Packet and AMTOR mailboxes—with selective control of third party traffic—are standard to the PK-232MBX.

Our extensive Host Mode control gives you unmatched power and versatility from computer support programs for DOS, Windows™, Macintosh, and Commodore computers.

Our highly trained service crew keeps you on track with helpful advice and in-depth knowledge of amateur radio.

When you're ready for a multi-mode controller with a proven track record, the PK-232MBX is the choice of champions.

For more information on the PK-232MBX, call AEA's Literature Request Line at (800)432-8873 or contact your favorite ham radio equipment dealer.

AEA

Connect with us